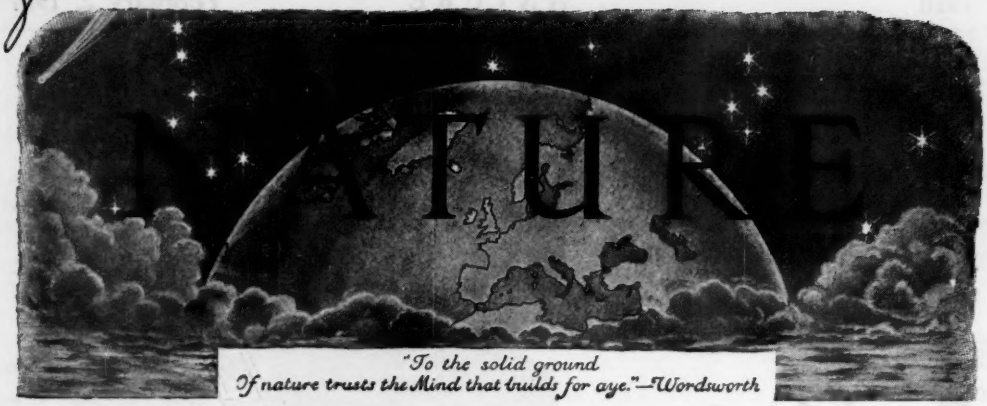

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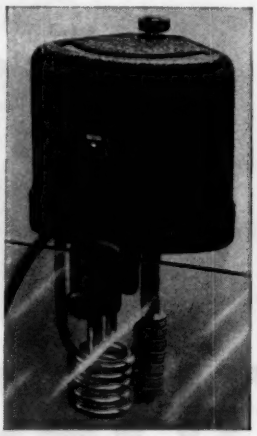

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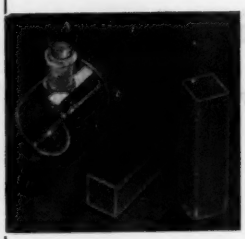

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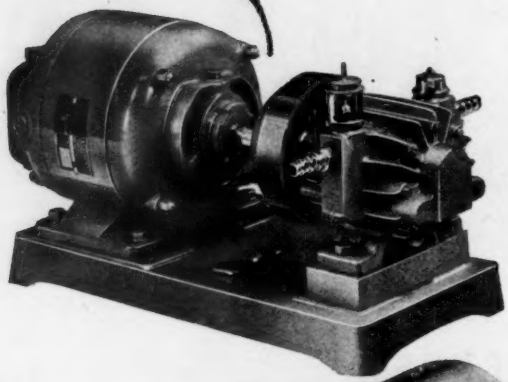

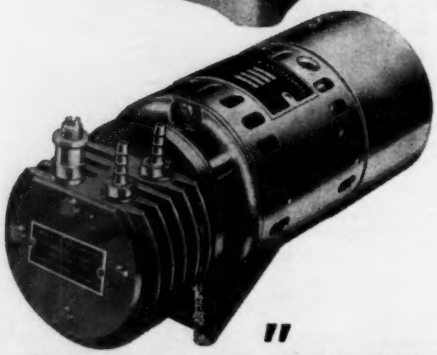

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AGENTS THROUGHOUT THE WORLD

NATURE

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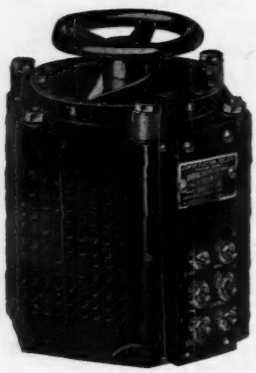

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SCIENCE AND HUMAN VALUES

THE three essays on "Science and Human Values" which Dr. J. Bronowski has contributed to recent issues of the *Universities Quarterly* are a revised version of the Carnegie Lectures which he gave at the Massachusetts Institute of Technology. In them—and especially in the third essay—Dr. Bronowski discusses the sense of human dignity and challenges widely held views of what science is and does. These views are highly relevant to the current task of developing—or even reshaping—the educational system of Britain so as to provide us with the scientists and technologists and technicians which we need in this age of technology. No less important, the educational system must provide us also with managers and administrators alive to the significance of scientific and technical advance and to the importance and bearing of human values. He develops indeed an ethic for science which derives directly from its own activity and accordingly fosters and even creates those human values, respect for which can safeguard us from the excesses of totalitarianism and automation.

In his first essay, Dr. Bronowski shows that science is a creative activity, not to be distinguished from other imaginative activities. Every cast of mind, he suggests, has its creative activity, which explores the likenesses appropriate to it and derives the values by which it must live. The exploration of the artist is no less truthful and strenuous than that of the scientist, and here as in science, in the act of creation, a man brings together two facets of reality and, by discovering a likeness between them, suddenly makes them one. The act of fusion is the creative act, and all science, Dr. Bronowski holds, is the search for unity in hidden likeness.

Leaving aside the bearing of this conception of creativity on the problem of creative research as it presented itself to the conference on the direction of *research establishments held at the National Physical* Laboratory last September, it is no less important in relation to education. Dr. Bronowski rightly observes that the spectator who is moved by the finished work of art or the scientific theory re-lives the same discovery; his appreciation also is a re-creation, and it might well be suggested that when the teacher fails to bring the student to the point of such appreciation, he has failed in his task, whether he be teaching arts or science.

Next, however, Dr. Bronowski examines the *question whether the likenesses which a science finds* have to conform to a sanction of fact from which the arts are free. Discussing the question of science and truth, he points out that the habit of testing and correcting the concept by the consequences in experience has been the spring within the movement of Western civilization ever since Copernicus. In science, in art and in self-knowledge, we explore and move constantly by turning to the world of sense to *ask, Is this so? This is the habit of truth, and it* is at the centre of science, not as a dogma but as a process, shaping the society which scientists have been compelled to form in the pursuit of science. Independence, originality, and therefore dissent, show the progress and stamp the character of our civilization: with freedom and tolerance they are the first needs of science, the values, which of itself it demands and forms.

Discussing finally in his third lecture the sense of human dignity, Dr. Bronowski observes that the society of scientists must be a democracy. It can keep alive and grow only by a constant tension between dissent and respect; between independence from the views of others, and tolerance for them, based not on indifference but on respect. It confronts the work of one man with that of another, and grafts each on each; nor can it survive without justice and honour and respect between man and man. Moreover, the company of scholars constituted by the men and women who practise the sciences is held together by a bond more durable than that holding together any modern State, and Dr. Bronowski suggests that ultimately the ordinary people respect the scientist more than his theories. By its nature, science must prize the search above the discovery, and the thinking (and with it the thinker) above the thought. In the society of scientists, each man, by the process of exploring for the truth, has earned a dignity more profound than his doctrine; and, taking a phrase from Buffon, Dr. Bronowski suggests that a true society is sustained by the sense of human dignity.

It is unnecessary to follow Dr. Bronowski into the detail of his argument to appreciate how much science, directly entering in this way into the human spirit, can contribute to make a human society work; and how largely our difficulties to-day are due to our neglect of science as a human value in itself, and of its power to foster the basic conditions of independence for the individual and toleration by the body of society, from which there follows step by step the *spectrum of human values: dissent, freedom of* thought and speech, justice, honour, human dignity and self-respect. Dr. Bronowski does not claim that the scientist can govern society; but he does insist that it is the scientist's duty to teach society the implications and the values in his work, that the command over the power of Nature needs at least as much devotion and understanding as its discovery. Fundamentally, the society of scientists, he urges, is *more important than their discoveries, the spirit of* science than its techniques.

More recently, in addressing the National Union of Teachers in London, on January 2, Dr. Bronowski urged that the prevailing attitude to science and technology is responsible for our slow progress in transforming the technical skills of the nineteenth century into those needed in our own time. Until we have created a society in which science is regarded *as a native accomplishment* and an important human value, he said, adequate finance will not be provided

for technical colleges, for example, nor will parents generally regard their children's higher education as important, or teachers of a requisite calibre be forthcoming. The present artificial division between science as a method of making things work and science as a method of understanding Nature, between *science as a technique* and science as a cultural and intellectual activity, he repeated, must be ended, and this requires a profound work of conversion in the minds of the administrative and government layer of society—and, it may be added, in many other layers of society.

Much of this is not new. More than a century ago, Shelley, in "The Defence of Poetry", argued that it is the task of the artist to absorb the new knowledge of science and assimilate it to human needs; but Mumford has pointed out how the scientist, given the freedom to pursue his method and preserve his vocational integrity, will pursue his research under social conditions which are crippling to an artist, a poet or a philosopher. We have seen too often in our day how easily the scientist is lured into serving tyranny to accept unquestioned the whole of Dr. Bronowski's argument, for all the force with which, like Mumford, he emphasizes that the only alternative to catastrophe is to allow science full opportunity to bring its values to the shaping of a society of the present day, in which knowledge is necessary to match and govern power.

What is important in Dr. Bronowski's addresses, however, is the way in which he demonstrates the bearing of these human values of science on the practical problems of to-day. Nor is he entirely new even here. Obviously, this precise bearing on the expansion of technical and technological education, on training for management, on the question of general education, whether in the sixth forms of schools or in the university, on such an experiment as that proceeding in the University College of North Staffordshire, on the supply of science teachers, and so on, can only be stated in the context of to-day. None the less, those implications were stated clearly in the report made by the Adult Education Committee of the Ministry of Reconstruction in 1919, which has recently been reprinted with some revision and additions under the title "A Design for Democracy". It is not simply that this report argued nearly forty years ago for wide opportunities for developing the study of natural science among adult students. It urged also the desirability of encouraging a wider diffusion of scientific knowledge and still more of the scientific habit of mind.

"Quite apart from the utilitarian reasons . . . for promoting scientific education . . . a wide appreciation of the methods and spirit of natural science ought to be an essential element in our national culture. . . . If this result is to be achieved . . . the scientific departments of our universities should regard educational work among extra-mural students as a normal part of their duties . . . and should be staffed to admit of their undertaking it. . . . Students with a natural gift for some branch of scientific inquiry would obtain opportunities of study which would be otherwise inaccessible to them. Not less important, the meaning and value of scientific work would gradually be more widely understood by all classes of the community."

The lack of progress over more than a generation in implementing views so cogently argued in 1919 should discourage any easy optimism. None the less, Dr. Bronowski's stimulating and highly pertinent addresses point the way afresh to much educational work to which scientists, concerned to play their part in the re-shaping of a society more fitted to deal with the problems of an age of technology and automation, might well address themselves both individually and through their professional associations. They indicate how much remains to be done before the Government's present plans for the expansion of scientific and technical education can have full effect, quite apart from the modification of those plans to deal adequately with the real needs. Above all, they are a challenge to thought which neither scientist, nor humanist, nor philosopher should ignore.

STORY OF THE ATOM BOMB

Atomic Quest

A Personal Narrative. By Dr. Arthur Holly Compton. Pp. xx+370+8 plates. (London: Oxford University Press, 1956.) 30*s.* net.

IN this book Prof. A. H. Compton describes the development of the United States atom bomb project from its effective inception in 1941. He describes the early contacts with the British project and how we suggested early in 1941, as a result of Cambridge work, that plutonium should be made in the Berkeley cyclotron and its properties studied to see whether it could be used as a nuclear explosive. He quotes a letter from Prof. Ernest Laurence to the National Academy Committee in July 1941, confirming that plutonium is fissile by slow neutrons and that it was likely that an atomic bomb could be made from it. There is also a record of a visit from Prof. M. L. E. Oliphant, bringing further news of British measurements and conviction that a uranium-235 bomb could be made. About this time the report of the British MAUD Committee was transmitted to Bush and Conant, and this reinforced the conclusions of the National Academy that atom bombs were feasible.

Thereafter, the book describes how the great United States project was built up. Prof. Compton became head of the 'Metallurgical Laboratory' in the University of Chicago. He describes how Fermi's first graphite reactor was built and the exciting story of how it became critical. The Laboratory was responsible for building further experimental reactors at the Argonne Laboratory near Chicago, and a pilot graphite reactor at Oakridge. At this stage of their project, in early 1944, the next formal British contacts with the reactor side of the American programme were made after the break caused by the 'Manhattan Project' re-organization. Together with colleagues from Canada, I visited Chicago and Oakridge to see their reactors, and the collaboration then established helped us to design the Canadian heavy water reactors.

Prof. Compton also describes in general terms the building of the Hanford water-cooled graphite-moderated production reactors, and how after the

initial start-up the reactor power decreased due to the formation of xenon 'poison'. Fortunately, the reactor had been over-designed deliberately and there was space to insert more uranium and provide the extra k required to overcome the xenon poison. The first few kilograms of plutonium were produced at Hanford in the first weeks of 1945.

Prof. Compton describes in great detail the agonizing discussions which went on among the scientists of the Metallurgical Laboratory and Los Alamos during 1945 as to whether the bomb should be used against the Japanese. The discussions were brought to the attention of the Secretary of State for War, Mr. Stimson, who appointed a representative 'Interim Committee' to advise him. At this point General Marshall stated that he would advise against its use in the war provided its existence could be kept secret. The general opinion was, however, that it would not be possible to keep its existence secret. A proposal to make a non-military demonstration likely to bring an end to the war was also thought to be impossible. After this, a poll of a hundred scientists of the Metallurgical Laboratory brought an 87 per cent vote in favour of its military use. The decision was taken by President Truman on the advice of Mr. Stimson, who has given his own account of these deliberations in "Foreign Affairs". The book describes the course of events in Japan and the difficulties of making the military agree to surrender, even after the dropping of two atom bombs, with their frightful destruction. Prof. Compton believes that the use of the bomb saved a very large number of lives, since he does not believe that the Japanese would have surrendered without bitter fighting in the next landings.

There are some errors in the book. It is stated that Pontecorvo was included in the team of physicists that Britain sent to aid in developing a successful atom bomb, and that he was acquainted with American war-time methods of bomb construction. Actually, Pontecorvo worked only in Canada on heavy-water piles; he had no contact with the United States bomb project and had no knowledge of the bomb.

In discussing radioactive contamination of the atmosphere by atom bomb explosion, the author questions whether a permanent increase by a factor of 100 in the general level of ionizing radiation would have a perceptible effect on the prospects of future generations. Such an increase would result in a world radiation dose to the whole population of more than 400 roentgens. It would increase the incidence of leukæmia by an order of magnitude and shorten life span appreciably; it would also increase mutation rates many times. It is forty times higher than that considered tolerable by the Committees of the National Academy of Sciences and the Medical Research Council Committee. Prof. Compton should read the reports of these Committees.

He states that no use has been found for radioactive fission products. Radiocæsium has already been used for radiotherapy in large sources, and the United States is building a plant for separating 200,000 curies a year.

Prof. Compton considers that modern conditions of war have placed it on a higher level of morality than war of the traditional type—that "the people back home who vote for war must recognize as they do that they themselves may be among those who will be destroyed. Under such conditions war will not be declared unless those who make the decision are so convinced of the importance and rightness of their national cause that they are prepared to risk their own lives and fortunes". Under present world conditions such a democratic process could apply in only a very few nations.

In general, Prof. Compton takes an optimistic view of the future, based on his deep religious and humanitarian feelings.

J. D. COCKCROFT

HARDINESS OF PLANTS

The Hardiness of Plants

By J. Levitt. (Agronomy: a Series of Monographs prepared under the auspices of the American Society of Agronomy, Vol. 6.) Pp. viii+278. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 7 dollars.

IT is common knowledge that while some plants are killed by the first moderate frost of winter, others survive without injury long-continued exposure to temperatures many degrees below the freezing point of water. Similarly with drought, some plants survive continued dry conditions in which others die sooner or later. Less familiar under natural conditions is the injury produced by high temperatures, but here also there is considerable variation among plants. It is with the problems presented by the varying ability of plants to survive such extreme environmental conditions that the present book is concerned.

Hardiness is defined by the author as ability to survive an unfavourable internal environment, so that cold hardiness, drought hardiness and high-temperature hardiness, the three phenomena considered, are respectively ability to withstand being cooled, ability to withstand drying and ability to withstand attaining a high temperature. The term hardiness is preferred to resistance, since cold resistance, for example, could mean that the plant remains warm when subjected to low temperature.

More than half the text of the book is concerned with the problems of frost hardiness. A very considerable amount of work, good, bad and indifferent, has been published on the effect on plants of freezing temperatures. This is summarized and discussed in some detail by the author and from a consideration of all the data a theory of the mechanism of frost injury and hardiness is enunciated. Essentially this is that killing by frost is brought about through mechanical injury to the protoplasm. As is well known, when ice forms in the protoplasm the cell is always killed, the ice crystals bringing about an irreversible change in the space relations of the protoplasm. However, when a plant freezes, water generally passes out of the cell and ice forms in the intercellular spaces. The cells are thus dehydrated and the protoplasmic 'consistency' (a combination of viscosity, elasticity and adhesiveness) increases and the protoplasm may become brittle, while contraction of the cell due to loss of water subjects the protoplasm to tension. As a result the tension may be sufficient to cause mechanical damage to the brittle protoplasm and hardiness is exhibited where the greater ductility of the protoplasm enables it to withstand the effects of the cell contraction. This theory the author holds is in agreement with the observed data relating to the freezing of plants and which are set out in the book.

From a consideration of the recorded observations on the effects of drought on plants the author considers that death through drought also, as Iljin had held, is due to mechanical injury brought about by the shrinkage of the cell through loss of water and the resulting tension to which the protoplasm is subjected by being pulled inward as the vacuole shrinks while it adheres to the more rigid cell wall. Here also hardiness depends on the avoidance of mechanical injury by the protoplasm under such conditions, and here also a considerable mass of data can be produced in favour of the theory.

While frost and drought injury can both be ascribed to mechanical injury resulting from loss of water from the cell, injury resulting from too high a temperature would appear to be due, as is generally supposed, to denaturing of the protoplasmic proteins. However, factors furthering dehydration hardiness also further heat hardiness, and the orders of hardiness of different cells to hydration and high temperature are similar. From such facts as these the author concludes that heat injury, like frost and drought injury, may be regarded as due to mechanical weakness of the protoplasm which renders it easily denatured by "thermally induced oscillations".

One small point puzzles the reviewer and that is the meaning attached by the author to the term 'tonoplast'. This expression was coined by de Vries to denote the inner plasmatic membrane or vacuole wall. When the author states that "ice may form between the wall and the tonoplast" and that this "may be the same phenomenon as the 'thin hull of ice inside the wall' " described by other observers, it would appear that the word 'tonoplast' is used for denoting something other than the internal plasmatic membrane.

The subject-matter of this book should be of interest to plant physiologists, agriculturists and horticulturists alike, and it is one of both purely scientific and economic importance. The production of the volume leaves nothing to be desired.

Walter Stiles

VARIATIONS ON A CYBERNETIC THEME

An Introduction to Cybernetics

By W. Ross Ashby. Pp. ix+295. (London: Chapman and Hall, Ltd., 1956.) 36*s*. net.

THE term 'cybernetics', after more than a hundred years of retirement among the writings of Ampère, burst anew on the scientific world just eight years ago. Its connotation has since varied and broadened until many of us have almost despaired of its usefulness as a scientific label. But it still has its users; and its very vagueness may yet allow it to be captured for a precise purpose by someone bold enough to stake his claim. Cybernetics, at this early stage, is as cybernetics does.

Much of Dr. Ashby's book is not about cybernetics of the sort that a reader of Norbert Wiener might recognize. He is concerned basically with a general theory of machines and their representation by mathematical transformations; and fully two-thirds of the book has gone by before the concepts of regulation and control are formally introduced. Let it be said at once that Dr. Ashby shows himself an excellent expositor, lucid, entertaining and imaginative of the difficulties that may arise in the reader's mind. His chapters are lavishly sprinkled with examples, to which answers are supplied, and there is no question that a reader of very modest mathematical background could in time follow the arguments through from start to finish. To this extent the claims on the flyleaf are more than justified.

What is less certain is whether the mastery of this transformation theory will most easily enable the reader (particularly the biologist whom the author has in mind) to "proceed without difficulty" (p. vi) to the study of more advanced work such as Shannon's on communication theory. Owing perhaps to the deliberate eschewal of differential calculus, the general climate of the book does little to toughen him against the rigours of more typical literature. He may even be lulled into a quite spurious confidence by Dr. Ashby's comforting use of biological situations to illustrate his theorems, though he may recognize that as applications of the theory they would not be thought very rewarding.

The truth is that there is no royal road to the detailed understanding of either communication theory or control theory, though there may be—indeed certainly are—results and applications which require but little mathematics of the user. Dr. Ashby gets around the difficulty only by teaching the reader the mathematics he wants for his limited purposes, and there is room for more expositions of this sort. But the picture which emerges is scarcely representative either of the scope or the power of the methods termed 'cybernetic', and it would be a pity if this should cause the real merits of the work to be overlooked.

For as an introduction to a new way of talking about mechanical systems the book is fascinating. Ashby's treatment of the 'decay of variety' in a determinate system is particularly illuminating, and his discussions of the concepts of 'system', 'model', 'black box' and the like are excellent in the clarity with which they distinguish his usage from other people's. Theoreticians of biology as well as of engineering will undoubtedly find much to stimulate them here.

Inevitably, perhaps, there are some pinpricks to disagreement. It seems confusing, for example, to speak of the number of components of a vector as its "length" (p. 81); and it is certainly inadequate to define "degrees of freedom" as the number of "components with independence giving the same variety" (p. 129) without specifying the number of values that each component may take. The definition of "feedback" on p. 53 deliberately ignores the distinction between informational feedback and mere Newtonian reaction, and is then defended in aggressive terms which obscure the real point in question. The same failure to distinguish information-sensitive from energy-sensitive actions vitiates later discussions, for example on pp. 57 and 238. The brusque rejection of "memory", for example on pp. 115–17 and 172, as something "hypothesized" for lack of a mechanical explanation, reads strangely in a day when most psychologists discuss both memory and its mechanical mediation with equal seriousness. A similarly needless dogmatism colours the definition of probability on p. 163.

Many other points of detail raise critical questions. Must all cybernetic systems be "closed to information" ? (p. 4). How does the fact that "feedback can be positive and yet leave the system stable" show "how unsuitable is the concept of feedback outside

its particular range of applicability" ? (p. 81). Does not the standard Nyquist theory of stability under feedback (nowhere mentioned) specifically include this case ?

How does the "law of experience" on pp. 138–9 guarantee that even a simple machine could be brought "each morning . . . to some standard state" by taking its input through some standardized routine "in the early morning" ? Surely the time taken must depend on the machine in question, and the only 'standard state' possible might well be one quite useless to the experimenter (for example, if the machine contained an irreversible counter with non-recurrent tallies) ? Again, how does Shannon's theorem on the capacity of a noisy channel "show that the problem" of the corruption of information in the brain (p. 191) "is a minor one" ?

Misleading generalizations of this sort are destructive of one's confidence, and it should be said that there are not too many. But the impression remains that it is the discriminating reader, in search of a new angle on an old subject, rather than the novice in search of a balanced presentation, who can be most confidently recommended to read this entertaining book.

D. M. MacKay

BONE METABOLISM

The Biochemistry and Physiology of Bone

Edited by Geoffrey H. Bourne. Pp. xiii+875. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 20 dollars; 143*s*.

BONE is a specialized connective tissue characterized by long branching processes which occupy cavities and fine canals in a hard, dense matrix of bundles of collagenous fibres in an amorphous ground substance impregnated with calcium phosphate complexes. It is not a static tissue but a plastic, actively metabolizing tissue. During the past twenty-five years, there has been a rapid development of new techniques. The present publication is the outgrowth of a belief that the time had come to collect the diverse studies published in a wide variety of journals into one integrated volume. The comprehensiveness of the present treatise by a panel of twenty-eight experts discoursing in some twenty-four chapters has nevertheless a unity despite some degree of overlap which is inevitable in a multi-author publication.

In his preface Dr. Geoffrey H. Bourne, the editor of the volume, points out that Frey in his manual of histology published nearly a hundred years ago summarized what is our present conception of bone when he wrote: "Owing to their hardness and solidity, the bones are peculiarly well adapted for the mechanical construction of the body. . . . They serve to protect internal organs, and form systems of levers. . . . The bones take part also, to a great extent, in the chemical occurrences of the organism, owing to the lively interchange of matter going on in them".

The introduction of new histological stains and metal impregnations and new biophysical techniques such as X-ray diffraction, polarization and electron microscopy, and the use of radioactive isotopes to the study of bone tissue, has thrown fresh light on the structure and physiological function of bone tissue. These are described in this most interesting series of contributions.

The organic and inorganic parts of bone together form a marvellous construction on the ultrastructural level, a construction that has good mechanical properties, but also has the ability to incorporate and exchange various ions at a very rapid rate. It serves in this sense to regulate the ionic milieu in the body. This quick pick-up and release of ions by some surface-exchange phenomena or recrystallization means that a number of radioactive isotopes introduced into the body become localized in the skeleton at specific 'hot spots' which may cause radiation sickness. One of the contributors points out that in our time, when each individual risks contamination with 'bone-seeking' radioisotopes such as products from uranium or plutonium fission, it is extremely important to study bone structure and physiology from the molecular to the anatomical level. A study of bone may help us to find specifics or principles for the detoxication of the skeleton with respect to radioisotopes. There is a special urgency for such research and this collection of reviews is timely. The text is very clear, fully documented and the illustrations remarkably good.

D. P. Cuthbertson

MORAL CODES AND ETHICAL THEORIES

Encyclopedia of Morals

Edited by Vergilius Ferm. (Midcentury Reference Library.) Pp. xi+682. (New York: Philosophical Library, 1956.) 10 dollars.

THIS book consists principally of a set of articles, varying in length from two to a dozen pages, on subjects which fall roughly into the following categories: expositions of the main tenets of eminent moral philosophers of all times; descriptions of the main types of ethical theory such as utilitarianism; descriptions of the moral ideals of influential religious and cultural groups such as the Quakers, the Chinese and the Jews; anthropological studies of the moral beliefs and practices of modern primitives such as American Indian tribes. These main articles appear in alphabetical order among a host of shorter articles which have no independent content but refer one to the relevant main articles and take the place of an index.

The main articles, all signed, are the work of a considerable body of American scholars. So far as a single reader of such a work can judge they are fair, clear in style and well proportioned; even when the reader may disagree it will generally be on a debatable point, for there is little sign of culpable ignorance or carelessness. The most obvious lacuna is the absence of any main articles on prominent moral notions and problems. This is presumably deliberate policy and might be defended on the ground that such articles would inevitably be controversial and thus out of keeping with the factual character of the rest. But the price paid is that if one looks up such a key notion of morality as 'conscience' one is simply advised to consult some twenty main articles, some of which refer to conscience only in passing.

This is not primarily a book for the specialist in the fields covered, since he will always know, or need to know, more on any topic than this book can tell him; though even he will find many things to interest him. But for the reader who might wish to know, accurately but in no great detail, Schopenhauer's views on moral philosophy, the general character of Hindu moral ideals, what Nietzsche said

(as opposed to what the Nazis or his sister said that he said), the theoretical attitude of Marxists to morality, or a hundred similar things, this book will be a reliable and sober guide.

If this assessment of the book's utility is sound, some slight criticism of the editor's policy is in order. He has been very generous to contemporary moral philosophers, both in the length and in the number of articles devoted to them; thus Dewey receives twenty-four columns against Plato's twenty-three and Kant's eighteen, and Broad receives ten columns in an article which points out that he has made no distinctive contribution to ethical theory. For non-specialist readers some of this space could have been better allotted to additional main articles on such topics as the following, all in accordance with the plan of the book, but in fact noticed only incidentally in other articles: Buddhist ethics, Epicureanism, casuistry, determinism, libertarianism, fatalism, taboo and theories of punishment.

The book is well produced and, though printed with two columns to the page, is set in good-sized, clear type.

J. O. Urmson

SCIENTIFIC MEDICINE

1956 Medical Progress

A Review of Medical Advances During 1955. Edited by Morris Fishbein. Pp. x+389. (London: McGraw-Hill Publishing Company, Ltd., 1956.) 41*s*. 6*d*.

Lectures on the Scientific Basis of Medicine

Vol. 4: 1954–55. (British Postgraduate Medical Federation: University of London.) Pp. ix+397+34 plates. (London: Athlone Press, University of London, 1956. Distributed by Constable and Co., Ltd., London; and John de Graff, Inc., New York.) 37*s*. 6*d*. net.

Medical Research

A Mid-century Survey. Vol. 1: American Medical Research: in Principle and Practice. Pp. xxxii+765. Vol. 2: Unsolved Clinical Problems: In Biological Perspective. Pp. xxxii+740. (Boston, Mass.: Little, Brown and Company; London: J. and A. Churchill, Ltd., 1955. Published for The American Foundation, New York.) 15 dollars; 105*s*. the two volumes.

THE volumes under review illustrate three aspects of medical education and appeal to three different groups of workers, namely, the practising doctor, the research worker and the administrator. Underlying them all is the common purpose of the dissemination of knowledge based on the realization that the rapidly advancing flood of science carries with it the grave danger of stultifying isolation for the individual in whatever field of work his main interest lies. On one hand, whether it be the care of the patient, the solution of a research problem or the direction of research the individual knows that to achieve success requires not only the use of appropriate methods but also continuous thought and immersion in his subject. On the other hand, he knows that since medicine has no bounds he must try to keep abreast with work in other fields; anywhere in these, and not only in the most publicized advances, may lie the clue that will solve his own problem. To help him to keep abreast, the human associations and the printed publication are legion.

"1956 Medical Progress" is directed to the practising physician and surgeon. Under the editorship of Dr. Morris Fishbein of Illinois it contains twenty-one brief review articles by American authors covering a large range of subjects. These vary in quality and critical approach but on the whole seem fairly to assess progress or lack of it during the past year. Dr. Fishbein picks out four as being the most exciting announcements of medical progress in the year, namely, the Salk vaccine against poliomyelitis, the further development of tranquillizing agents, the appearance of several new antibiotics with remarkable properties and the report from Germany of a new substance (BZ 55) to be taken by mouth for the control of blood sugar.

"Lectures on the Scientific Basis of Medicine" are directed to the younger research worker and future consultant and specialist, and are well worth their attention. The present volume, the fourth, continues the publication of the excellent series of lectures given annually in London under the auspices of the British Postgraduate Medical Federation. The twenty-one lectures published (thirty were delivered) are, as in the past volumes, all by workers well known in their own field and make interesting reading. As would be expected from current trends the emphasis is on the biochemical approach. The older disciplines, however, are not neglected, for Sir Victor Negus deals with the comparative anatomy of the larynx. Four of the lectures cover various aspects of injury: shock from burns by J. P. Bull, the electrolyte and metabolic response to trauma by G. M. Wilson, reaction of enzymes to injury by J. D. Judah and radiation injury to bone by Janet Vaughan.

"Medical Research, a Mid-century Survey" is the product of years of work by the staff of the American Foundation (Esther Everett Lape and her associates) under the chairmanship of Curtis Bok and with the assistance of a committee of consultants well known in the field of American medicine and allied subjects. According to the introduction, "the most urgent of present national needs in the medical field is thus conceived to be expansion and improvement of medical education integrally related to research, and progressive improvement of medical practice, steadily lessening the empirical nature of applications of new knowledge to medicine. The medical research involved must be in biological perspective, utilizing the contributions of chemistry, physics, mathematics and the results of research on atomic energy". The first volume contains an account of American medical research in principle and practice dealt with in five chapters: (1) Medical research in perspective of biological, chemical, physical and mathematical science. (2) Current trends and current problems in medical and biological research in the United States. (3) Research agencies. (4) Clearing of results and controlling progress of medical research. The second volume surveys in ten chapters unsolved clinical problems in biological perspective and includes such topics as cancer, hypertension, alcoholism and schizophrenia. While the other two books referred to above lend themselves to easy reading and digestion, the same cannot be said of this American survey. To paraphrase a remark made on page 702 (Vol. 1), the use of this painstaking survey is likely to be impeded by its very volume, for it occupies no less than 1,505 pages. The reviewer has found it difficult to trace his way through the trees of the forest, and feels the need of a brief and constructive summary. The survey will probably be of use to the research worker and the administrator as a reference book on American views.

R. T. Grant

Kinetic Theory of Liquids

By Prof. J. Frenkel. Pp. xi+488. (New York: Dover Publications, 1955.) Cloth, 3.95 dollars; paper, 1.95 dollars.

THIS Dover edition is an unaltered and unabridged re-publication of the first English translation of Prof. J. Frenkel's book published by the Oxford University Press in 1946. The conventional text-book theory, which derives the properties of liquids by considering the transition between the liquid and gaseous states, is now known to be valid only at temperatures near the boiling point. Prof. J. Frenkel, in this book, develops the modern theory that, at temperatures near the crystallization point, a consideration of the analogy between a liquid and a crystalline solid leads to a better understanding and explanation of the properties of liquids. In particular, it is shown that liquids and crystalline solids, apparently so divergent in properties, differ fundamentally only in the degree of order of their structures.

Among other topics dealt with are those of viscosity, rigidity, surface tension, surface films, the polarization and conductivity of liquids, and the kinetics of crystallization. There is also an important chapter dealing with the properties of high-polymeric and rubber-like substances. The general treatment of the subject-matter, particularly the mathematical portions, is much to be commended for its logical, clear presentation. Many references are given, and the text is well illustrated with line diagrams.

In the preface, the author expresses the hope that the book will serve as an introduction to the new theory for physicists and chemists at large; but it is probably true that, for the run-of-the-mill scientist, a simpler exposition would fulfil this purpose rather better. However, the book should be invaluable, both as a text-book and a work of reference, to those interested in the liquid or quasi-liquid states of matter; to those engaged in research in this field, many interesting and fundamental problems are suggested.

Principles of Organic Chemistry

An Introductory Text in Organic Chemistry. By Prof. James English, Jr., and Prof. Harold G. Cassidy. Second edition. Pp. xiii+469. (London: McGraw-Hill Publishing Company, Ltd., 1956.) 49*s*.

IN writing this full-year course of organic chemistry for university students, the authors, professors at Yale University, have made a judicious blend of theoretical and factual matter. The book's twenty-four chapters describe a carefully made selection of the alkyl and aryl compounds generally studied in introductory courses, and in addition consider the several types of substituted acids, colour and constitution, stereoisomerism, carbohydrates, polysaccharides, proteins and plastics.

In the last chapter heterocyclic compounds are briefly treated. Alkyl and aryl compounds, after Chapter 5, are treated together. The compounds and reactions described, including those newly discovered which have especial instructional value, have been chosen more for their worth in giving a grip of theory than for their economic and industrial application. A general account of the electronic theory is given early in the book, then more theory is introduced, piecemeal, as a compound or reaction suitable for its illustration is met. Thus resonance, together with conjugation, is taken with the study of the olefines, the molecular orbital theory with acetylene, and reversible redox systems with the study of the quinones. Reaction mechanism is stressed throughout.

Helpful historical notes dispersed throughout the text and valuable footnotes add to the interest of the book. In this edition the authors have rewritten sections to improve the clarity of presentation and have used curved arrows to indicate the courses of reactions. The book is written up to the level of the freshman intending to study chemistry seriously and is calculated to promote an understanding and enjoyment of the science. G. Fowles

Bibliographie des langues aymará et Kicua

Par Paul Rivet et Georges de Créqui-Montfort. Tome 51. Vol. 4. Pp. iii+957. (Paris: Institut d'Ethnologie, 1956.) 6000 francs.

THE veteran French anthropologist, Prof. Paul Rivet, announced the publication of Vol. 1 of the great bibliography of the Aymará and Quechua languages of highland Peru, Bolivia and Ecuador, of which he is joint author, by presenting copies to the First International Congress of Peruvianists in Lima in 1951 and the Thirtieth International Congress of Americanists in Cambridge in 1952. The work is arranged chronologically, the items being listed under their years of publication, and Volume 4, which covers the years 1941 to 1955, brings it up to date. It also contains additions and corrections to the earlier volumes.

In addition to bibliographical notes, a few words of appraisal are given in appropriate cases, and some title pages are reproduced. The work is extremely comprehensive, and includes many items in other languages, for example Karsten's "Ceremonial Games of the South American Indians", because they contain some Quechua or Aymará words. It is a necessary work of reference for historians of the Andean region.

G. H. S. Bushnell

Naturecraft in Australia

An Introductory Handbook to the Fauna and Flora and to the Australian Environment for the use of the Bushwalker, Student, Field Naturalist, and Conservationist. Arranged and Edited by Thistle Y. Harris. Pp. xvi+264+24 plates. (Sydney and London: Angus and Robertson, Ltd., 1956.) 25*s*.

MISS T. HARRIS, of the Sydney Teachers' College, has already done a good deal to generate interest in the Australian countryside. This volume, which is published under the auspices of the Wild Life Preservation Society of Australia, continues this useful work. In this book, which is edited and in part written by Miss Harris, a number of Australian naturalists have combined to describe (in 237 pages) the geology and natural history of a continent. The result is not, of course, a contribution to science; indeed it is a pity that valuable space is taken up with long lists of the Latin names of birds, fishes, and plants, because these lists give the reader a false impression that the book might be a naturalist's handbook. As a handbook "Naturecraft in Australia" could not be recommended. But it can be recommended as a book to stimulate interest on the part of Australians in their bush and their sea coasts; and its twenty-four photographic plates (which are of much higher quality than the text) will give the naturalist who is not able to visit Australia a vivid idea of some of the common insects and snakes and birds and plants which occur there. E. Ashby

ORIGIN OF THE EARTH'S CRUST

By Prof. J. TUZO WILSON

Geophysics Laboratory, Department of Physics, University of Toronto

THE surface features of the Earth are strikingly different from those of the Moon. This requires explanation, because these bodies are generally considered to have been companions in space, subjected to the same external influences for several thousand million years. The Moon's surface is cratered, probably by the impact of large meteorites, and it appears to be partly covered by lava. It is usually supposed that this is an ancient surface little altered since the Moon's early history, and that it is the Earth's surface, once similar, which has been modified. One cause of change which has been suggested is erosion by air and water, but this is not enough. Erosion would have levelled former features, but it could not have built high continents and mountains.

I wish to suggest that the material of the entire crust has been derived from lavas extruded from the mantle of the Earth during geological time, to propose an outline of a possible manner of growth, and to point out that the Mohorovičić discontinuity at the base of the crust is likely to have been the Earth's early surface, corresponding to that of the present face of the Moon. The growth of the crustal features has been controlled by a system of fractures and made possible by suitable conditions in the interior of the Earth. The lava has been accompanied by gases and steam, which, as others have already suggested, formed the atmosphere and oceans.

Consider first the probable sources of the atmosphere, oceans and crust. Rubey has recently summarized the evidence concerning the atmosphere and hydrosphere and concluded that it seems likely that they "have accumulated gradually during geologic time by the escape of water vapor, CO_2, CO, N_2, and other volatiles from intrusive and extrusive rocks that have risen more or less continuously from the deep interior of the earth"[1].

Shillibeer and Russell[2] have also calculated that the volume of argon-40, which constitutes 99·6 per cent of atmospheric argon, is such that it could have been generated during the Earth's history from the potassium-40 present in all the rocks above the Mohorovičić discontinuity, if it had been released as they were poured out in a molten state.

The solid crust of the Earth can be considered to a first approximation to consist of a layer of basalt 5 km. thick extending under both oceans and continents, upon which are superimposed continental blocks, 30 km. thick[3], the surface composition of which has been shown to be close to that of andesite with 59 per cent silica (SiO_2) (and not granite as is often stated)[4]. This basaltic layer has a volume of about $2{\cdot}5 \times 10^9$ km.^{3}, and the andesitic layer $4{\cdot}5 \times 10^9$ km.^{3}.

Sapper has estimated that the average rate of emission of lava since A.D. 1500 has been greater than 0·8 km.^{3}/yr.[5]. The thermal history of the Earth suggests that this rate may have been higher in the past[6]. Recycling of lava is improbable, because the oceanic crust is too thin to be re-melted and because recent seismic investigations have shown that the West Indian[7] and Aleutian[8] volcanic arcs must be fresh additions. Both arcs are predominantly andesitic and rise from typical basaltic ocean floors which are found on both inner and outer sides of the arcs. Other arcs are probably similar.

The whole crust could therefore have been formed during the probable age of the Earth, $4{\cdot}5 \times 10^9$ yr.[9], at an average rate of volcanism only a little greater than that estimated for the present. The main parts of the crust have approximately the same composition as basalt and andesite, which are by far the commonest lavas[10].

The volume and composition of the atmosphere, of the hydrosphere, and of the whole solid crust above the Mohorovičić discontinuity therefore appear to be compatible with the theory that they have been formed by volcanic extrusion during the Earth's history.

The active volcanoes nearly all rise along one of the two great fracture systems, which have therefore controlled the formation of the principal features of the crust. Along one of these systems, the simpler and less active, lie the mid-ocean ridges. Ewing[11] has just suggested that the mid-Atlantic ridge, which is already known to be continuous from the Arctic to Tristan da Cunha, turns and continues beneath the Southern Ocean south of Africa to connect with the Carlsberg Ridge in the Indian Ocean and thence south of Australia to connect with the principal ridges of the Pacific Ocean. Numerous earthquake foci, all shallow, lie along this continuous system. In many places the ridges have been shown to be rifted or to have scarps due to fracturing. Most of the volcanoes are only feebly active and all emit predominantly basaltic lavas of the basalt–trachyte, Atlantic or calcic suite. They contain ultra-basic inclusions, but no granitic ones. All that we know of these volcanoes is compatible with the view that they may have risen along a continuous zone of shallow fracturing (less than 70 km.) by partial melting and differentiation of the mantle at depths of a few tens of kilometres.

The rate of emission of lava is so low that these vast ridges, hundreds of miles wide, with crests two to seven miles high, must have taken most of the Earth's history to accumulate.

Although there is considerable evidence that large loads on the crust sink and are depressed, such ridges could not have disappeared. Few comparable ridges exist which are not seismically active (for example, the Lomonosov ridge[12]). This is an indication that these ridges have not migrated.

The continents are related to another more active system, which, unlike the first, has migrated in the past, but which at present has the shape of an inverted T folded about the Earth[13]. Along it are all the active andesitic volcanoes and all the deep earthquakes (up to 720 km.) and a majority of the shallow ones. The stroke of the T is formed by a belt extending across southern Asia and Melanesia

Table 1. Stages in Mountain Building

Stage	Example	Initial event in stage
(1) Island arc	Aleutian Islands	Formation of arcuate fracture
(2) Active mountain arc	Coast mountains of British Columbia	Uplift and metamorphism of former island arc
(3) Inactive mountain arc	Appalachian Mountains of New England	Migration of active fracture system to another location
(4) Province of a shield	Grenville province of Canadian Shield (contains several arcs)	Gradual erosion

from the Mediterranean to New Zealand. The stem is another belt which joins it at Celebes and extends clockwise around the borders of the Pacific Ocean. Except for the limb from Celebes to New Zealand, the irregularities of which are discussed elsewhere[14], both belts are made up of a series of arcs joined end to end. All are in stages 1 or 2 of the sequence of evolution of primary mountains given in Table 1.

The lava extruded along these arcs does not, of course, remain unaltered. Most of it is rapidly eroded to sediments, which accumulate in the vicinity of the arcs, later to be 'granitized', uplifted and eroded again.

Since only basaltic lavas rise along the mid-ocean fracture system which has only shallow earthquakes, and since andesitic lava with a little basalt rises along the continental fracture system which has all the deep earthquakes, I think it reasonable to conclude that basalts are formed by partial melting of the shallow layers (tens of kilometres deep) and that the andesites are a differentiate from deep layers (hundreds of kilometres deep). Andesites rising from great depth would be superheated and capable of melting some basalt, explaining the mixture of lavas over deep fractures.

From time to time parts of the active fractures forming this continental fracture system have shifted, leaving the abandoned arcs to decline through stages 3 and 4 of their evolution. For example, activity was transferred from the Hercynian Mountains to the Alpine–Himalayan Mountains by a step outwards. On the other hand, part of the system moved to an entirely different location when the Appalachian–Ouachita system which had been joined to the United States Cordillera in Palæozoic times became inactive, while at the same time fresh fractures formed to link the Cordillera to the Andes through the Caribbean region for the first time. Again, that part of the fracture system which joins the Yukon to Japan lay through the Brooks Range of Alaska and the mountains of eastern Siberia until Mesozoic time, when it shifted forward to form the Aleutian and Kurile arcs. Thus do continents grow outwards, by adding a range or a province at a time. Sometimes the additions are parallel to their predecessors, sometimes they move to another coast. After a few hundred million years in one place, the channels become choked or the sources of lava are exhausted and the arcuate fractures move elsewhere; but in the meantime enough new rock has been added to the continental crust to form another province. It does seem that at all times the fracture system is long and continuous.

Those continental shields for which there are sufficient age determinations[14,15] have been found to be zoned, with progressively younger provinces arranged about one or several continental nuclei. A dozen of these have been identified[16]. They have special characteristics, but the details of their structure and the exact manner of their formation are not yet known. Their lavas appear to be principally basalts, suggesting that at that early time ($2–3 \times 10^9$ yr. ago) the principal fractures did not penetrate deeply enough to tap the layers which produce andesites.

The boundaries between provinces are large fault systems, close to which most of the largest ore bodies (at least in the Canadian Shield) are arranged[17]. In view of this, it is not surprising that recent studies of the isotopic ratios in lead ores have been interpreted to mean that the majority of these ores have risen directly from the mantle, presumably using major faults as channels[18]. In young regions, the simplicity of this arrangement has been obscured by the folding of young strata over the faults of the basement and by migration of ore-bearing solutions through them. Nevertheless, the relation of these ores to large hidden faults has been postulated[19].

Besides these two systems of fractures, one shallow and stationary and the other deeper and migratory, one would expect ancillary fractures springing from them and connecting them. Such may include graben and ocean scarps such as those recently described by Menard[20].

The extrusion of the crust would cause about 100 km. contraction in the original surface, which is more than double that to be expected by thermal cooling without any phase changes (Allen, D. W., personal communication) and contraction after the manner proposed by Jeffreys[21].

The change from island-arc stage to active mountain stage is apparently a fairly sudden event. Saull[22] has suggested that the transformation of sedimentary minerals to metamorphic minerals may be exothermic. It may also involve a decrease in density. If true, this would explain the rapid transition of old and large eugeosynclines into elevated plutonic ranges. Parts of the metamorphic rocks may be mobilized and some plutonic rocks may form by solidification of lavas at depth; but the bulk of the crust is considered to be formed by the metamorphism of sediments derived from lavas. Cover rocks at the margins of mountain uplifts undergo foreland folding by gravity slumping.

The emission of lavas from the interior, and the sudden metamorphism and uplift of accumulations of sediments derived from them, would disturb the Earth's principal moments of inertia and may thus have caused polar wandering[23]. If so, the comparatively recent uplift of Alpine, Himalayan, Cordilleran and Andean mountains should have caused considerable shifting and may have brought the poles to their present land-locked positions, causing the present ice age[24].

Any polar migration must distort the Earth's surface, and one would expect the resultant shearing to be concentrated whenever possible along existing belts of weakness. This may explain the large transcurrent faults like the San Andreas of California[25] and the Alpine Fault of New Zealand[26], which appear to have been superimposed in Mesozoic or Tertiary time on pre-existing mountain building structures. They are at present moving so rapidly (about 1 in. a year)[27] that their present activity must be of fairly recent origin.

Admittedly parts of this thesis are speculative and invite investigation, but it is an attempt to unite

and explain observations from many different fields. Fuller accounts are in preparation.

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SWINDEN LABORATORIES OF THE UNITED STEEL COMPANIES, LTD.

RESEARCH AND DEVELOPMENT IN IRON AND STEEL

By J. H. CHESTERS
Assistant Director of Research

THE Central Research Department of the United Steel Companies, Ltd., established at Stocksbridge, near Sheffield, in 1934, was already much too small for the work in hand by the end of the Second World War. New laboratories, named after Dr. Thomas Swinden, the first director of research, were, therefore, built at Rotherham and officially opened in 1952. With the new director, Mr. F. H. Saniter, came not only new laboratories and new sections, but also a completely new group dealing with plant development. To the original metallurgy, chemistry, physics, X-ray, and refractories sections, were added others dealing with minerals, fuel, furnace design, mathematics, high-temperature metals, and welding. The development group, designed to cover all aspects of iron and steelworks engineering, was sub-divided into sections dealing with works layout and general engineering, ironmaking plant including blast furnaces, steelmaking plant, reheating furnaces, rolling mills and engineering standardization. In addition, it included a small but versatile design and drawing office. The new department, with its twenty sections and a staff of about 235, can best be considered under the main groups of plant, process and product.

Plant

Although logically the plant comes first, it can only be designed in terms of the process to be operated and the product to be made. It must, therefore, be continually subject to changes caused by research in these fields. Because many of the new ideas come from outside and some of them from other countries, it is part of the development engineer's task to keep abreast of progress. This means not only wide reading but also frequently foreign travel. Before new plant can be installed, additional information may be required, and this may call for research or development within the laboratories or for pilot-scale work within a steel-plant. A good example of the latter is given by the development of the Austeel–Escher metallic recuperator.

This new type of heat exchanger was developed in Australia during the Second World War and was used for preheating combustion air for gas- or oil-fired soaking-pits (the furnaces used for heating ingots prior to rolling). This had generally been achieved either by checkers, as used in open-hearth furnaces, or by refractory tile recuperators with their attendant risk of leakage. The new metallic type consists essentially of two concentric steel tubes, differing in diameter by only a small amount, say $\frac{1}{4}$ in. The flue gases from which the heat is to be extracted flow through the inner tube, which may be of the order of 3 ft. inside diameter and about 20 ft. long. The air, or gas, to be preheated flows through the annulus between the tubes, either parallel with or counter to the waste gas flow. Heat is exchanged from the flue gas to the air or gas through the wall of the inner tube, which is usually made either of heat-resisting steel or of mild steel lined with refractory.

A pilot unit (Fig. 1) was built in a nearby steel-plant and arranged to take the waste gases from a disused forge furnace. The location was chosen because fuel and power supplies were available, together with trained erection and maintenance men and adequate handling equipment. A series of test runs was carried out using parallel and counter flow, both with and without refractory linings. The data collected included such factors as flue gas, air and recuperator metal temperatures, gas and air flows, pressure drop and flue gas analyses. The results were afterwards published[1]. This showed not only that this type of recuperator was satisfactory for use in conjunction with soaking-pits but also provided in addition a check on the methods employed in calculating heat transfer. A number of soaking-pits

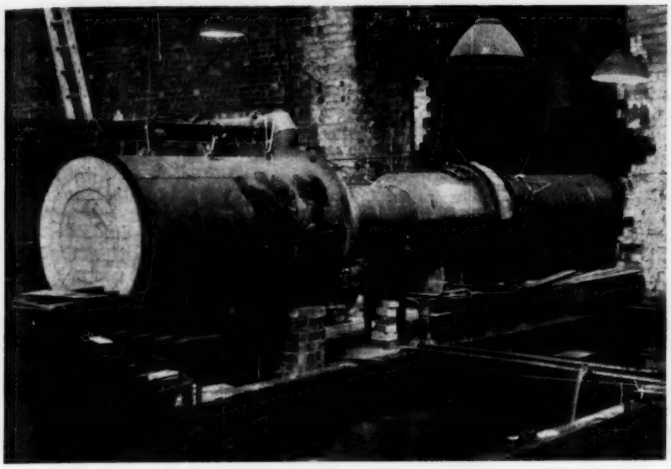

Fig. 1. Pilot scale recuperator under test

were afterwards equipped with this type of recuperator and have, over several years of operation, shown economies of the order predicted from the test run. In addition to more efficient use of fuel, better control has been obtained over pit atmosphere, maintenance costs have been lowered and availability increased.

Process

Although iron- and steel-making must eventually be describable in terms of applied mathematics, physics and chemistry, the fundamental approach can by no means always be applied, and resort must, therefore, be had to numerous technologists, for example, those concerned with ore preparation, refractories, fuel and process chemistry. Since many operations, for example, steel production, involve these technologies simultaneously, it is not surprising that co-operation between sections is found to be vital. It might, for example, be thought that the sintering of iron ore was essentially a mineralogical problem, but our work in this field shows that aerodynamics may be equally important. Indeed, the key to the empirical laws governing sinter output came from the ability of the research team to make flow measurements under relatively difficult conditions[3]. Large-scale trials showed that the output, even from existing plant, could be doubled provided the permeability of the feed was sufficiently increased. Ways of doing this, for example, by increasing the water content of the batch, or by pelletizing the fines[3], were demonstrated in the laboratory and have since been applied in practice with substantial gains.

Co-operation on a still wider scale is demanded by work on open-hearth furnace roofs. Although these only account for approximately 5 per cent of the total cost of the refractories used in steelmaking, the roof life tends to determine the time between major shut-downs and is, therefore, of peculiar importance. Throughout its life, generally of the order of 12 weeks, the silica roof is kept at a temperature close to its melting point and is bombarded with substantial quantities of molten iron oxide. It must be capable of maintaining its sprung-arch shape and must be repaired or removed whenever there is any risk of collapse, premature failure meaning not only loss of a roof but probably also of the expensive steel beneath. The drive for greater output, based in the main on increased firing rates, has led to shorter roof lives, but as a result of extensive research this trend has even been reversed; roof lives to-day being if anything greater than ten years ago in spite of much greater production rates. This change resulted from co-operative studies of the raw materials[4] used for brickmaking, of manufacturing methods[5], and of instrumentation[6] and design of open-hearth furnaces[7].

The rumour that bricks made from certain South African chalcedonic quartzites gave lives on South African furnaces better than could be obtained with imported materials, although the bricks were made by relatively unskilled labour, led to an inspection of the deposits by our geologist, and the subsequent importation of substantial quantities of materials for works trials. The improvements shown in split roof trials (see Fig. 2), where the new material was compared with standard, were far greater than would have been predicted from existing theory. Indeed, in certain of the trials roofs of this silcrete-type material were actually used for a second run on the same furnace. The improvement has still to be completely explained, but it is fairly certain that high density and low flux content (titania excluded) played a major part. This conclusion led to the trial of bricks made from specially selected British quartzites or flint pebbles, and performances equal to those given by the imported material are now being obtained. Further trials indicate that these so-called 'super-duty' silica bricks can best be used in the critical areas in roofs, for example, as a strip adjacent to the back and front walls, rather than for the roof as a whole.

Even ten years ago the continuous measurement of roof temperature was considered a hopeless task; but research has now reached the point where many steel companies have all their furnaces equipped with roof pyrometers and several make use of automatic roof temperature–fuel flow linkage. Unfortunately, the fact that the control point on a roof does not exceed a maximum safe temperature of, say, 1,650° C., does not mean that other parts are equally well

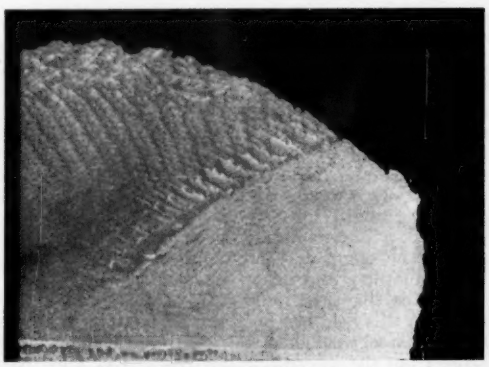

Fig. 2. Split roof trial on open-hearth furnace, showing marked contrast in silica brick quality

Table 1

Steel No.	1	2
Quality	½ per cent Mo	½ per cent Mo with boron
Analyses		
Carbon, per cent	0·09	0·08
Manganese, per cent	0·43	0·40
Silicon, per cent	0·25	0·25
Molybdenum, per cent	0·58	0·58
Boron, per cent	—	0·003
Mechanical properties		
Material: ¾-in. diam. (forged) bar		
Heat treatment: 930° C., a.c.		
Tensile strength, tons/sq. in.	28·5	41·0
Yield stress, tons/sq. in.	16·2	34·8*
Elong. on $4\sqrt{A}$, per cent	40·0	26·0
Redn. of area, per cent	74·0	71·3
Izod impact, ft. lb.	99	93

* This corresponds to 1·0 per cent extension on 2 in., no true yield stress existing.

treated. Extensive furnace trials and aerodynamic studies[8], both in the laboratory and works, have shown that certain designs, for example, the single-uptake, used in conjunction with correct steam/oil ratio to give optimum flame length, can minimize such temperature differences and, therefore, enable the best use to be made of available refractories. Great benefit has been obtained in these furnace trials, which necessitated simultaneous measurements by as many as thirty different investigators, achieved by close co-operation with research teams from the British Coal Utilisation Research Association, the British Iron and Steel Research Association, and more recently the Fuel Technology and Chemical Engineering Department of the University of Sheffield. In one of the latest trials[9], an attempt was made to check a mathematical theory of heat transfer by radiation with actual service data. It was found that the observed heat transfer could be largely explained in terms of radiation, and by at least partially confirming the mathematical theory, enabled calculations to be made with some confidence of the effect of such changes as conversion from single to twin burners.

The new science of furnace design, which involves the study not only of flow pattern and mixing pattern but also of the dynamics of liquid iron oxide droplets in gas streams, is still at an early stage; but it has already reached a point where improvements have been successfully predicted from such changes as burner movement. Furthermore, completely new ideas are being developed, for example, the use of moving air curtains for the protection of refractories from flux-laden gases.

Product

Although carbon steels, in the form of billets, plates, structural sections and rails, constitute the bulk of the Companies' production, much metallurgical research is concentrated on alloy steels, due to the heavy demands made on materials by the aircraft and power industries, including atomic energy. In the ferrous field relatively little can be done to reduce weight by normal alloy additions, but greater strength for a given weight can often be provided. Unfortunately strength alone does not satisfy the engineer, who requires in addition adequate ductility and often weldability.

Perhaps the most interesting of our own developments in this field has been the production of a high-strength steel with good weldability. Its composition arose from the interesting discovery that when only 0·002 per cent of boron was added to a low-carbon steel containing ½ per cent molybdenum, the yield strength was doubled and the maximum stress increased by about 50 per cent[10]. Typical test data are given in Table 1.

It might well be asked whether it is possible to get good distribution throughout, say, 60 tons of product when the boron added is less than 1 oz. per ton. Actual results show that, in fact, the variation throughout a cast is extremely small and indeed less than that of most other elements noted. The degree of consistency is illustrated in Table 2.

Table 2

Plate thickness	Boron, per cent	
	Soluble	Insoluble
¼ in.	0·0035	0·0001
½ in.	0·0032	0·0002
¾ in.	0·0032	0·0002
⅞ in.	0·0033	0·0002
1 in.	0·0033	0·0002
1¼ in.	0·0034	0·0001

Much research was, however, necessary to find ways of introducing the boron in an effective, that is, soluble, form, this element readily combining with both oxygen and nitrogen, which render it ineffective. Fixation of the oxygen and nitrogen was ultimately achieved by additions of titanium and aluminium, or of aluminium alone. No difficulty has been encountered in maintaining such control in practice, and the new steel has now been successfully made in high-frequency, electric arc and in both hot- and cold-charged open-hearth furnaces.

As will be seen from Fig. 3, the amount of molybdenum required to give the desired properties is critical. With less than 0·2 per cent molybdenum, the boron addition has little effect on the properties, but with 0·3 per cent a marked improvement in yield strength is obtained. In practice a lower limit of 0·40 per cent is used for ensuring the desired properties.

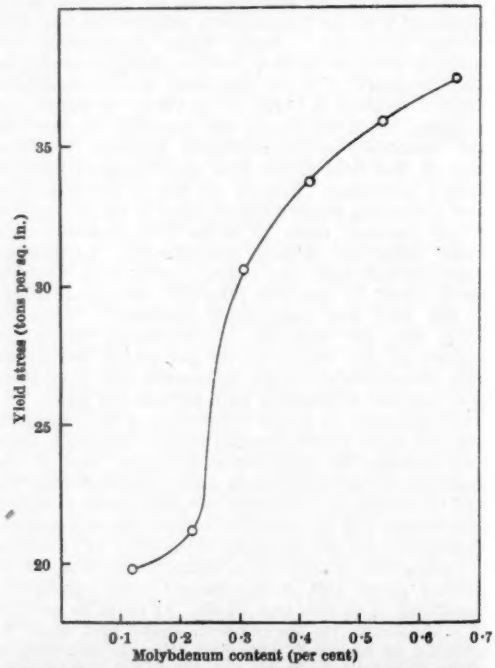

Fig. 3. Effect of increasing molybdenum content on the yield stress of 0·13 per cent carbon steel containing boron

The effect of the boron addition is to retard transformation of the austenite on cooling, with the result that the steel transforms at a lower temperature and in place of the normal ferrite/pearlite structure an acicular-type ferrite is formed. The effect of retarding the transformation is such that normal properties can be obtained in quite large sections of the order of 7-in. diameter and greater. Although the transformation is lowered with quite slow rates of cooling, it does not vary greatly when the rate of cooling is increased. This is an extremely important feature in regard to welding and explains the freedom from cracking of this steel during fabrication.

A striking illustration of freedom from cracking during welding was given by tests carried out under conditions of severe restraint and at a temperature of −76° C. Examination after a period of 60 hr. failed to reveal any cracks.

The normal properties are readily obtained in the form of plates, sections, sheet, tubes and forgings, but it is mainly as sections and sheets that the steel has found its widest use. An interesting application is in aero gas turbines, where it has replaced mild steel by thinner sections and in fabricated form has replaced light-alloy castings. In addition to the advantages of high strength and easy weldability, it has good high-temperature strength—a vital requirement with gas turbines.

The largest application has, however, been for military bridges, notably the heavy girder bridge, which has succeeded the well-known Bailey bridge. Higher working loads have thus become possible and with the added advantage that the desired properties can be obtained in the as-rolled material—no subsequent heat-treatment being required. Another interesting application is its use in a crane grab, which enables the pay-load to be increased from 5½ to 6½ tons.

Future Developments

It is not possible in so short a space to discuss the 250 or so investigations at present in hand, nor can any adequate indication be given of the exciting developments still envisaged. To the already existing facilities have been added an 11-in. 3-high rolling mill and more recently vacuum melting and pouring equipment, while excavations are already taking place for a new laboratory of the development type, in which pilot scale studies on furnaces can be carried out. In many fields, for example, continuous casting and all-basic furnaces, there are signs that earlier work may soon reach the application stage, while many new works trials are planned to improve the efficiency of existing processes. Increased use is envisaged of electronic digital computers, and with this in mind the Company has recently shared the purchase of such equipment with the University of Sheffield. Arrangements are already being made to obtain data in digitized form, and it is hoped that in this way research—like industry itself—may benefit by a general speeding up of its techniques.

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MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

PROPOSALS FOR EXPANSION

PROPOSALS for the development of the Manchester College of Science and Technology are set forth in a pamphlet recently issued* by the principal, Dr. B. V. Bowden. Without recapitulating the history of the College itself, which was given in the handbook issued in 1902 in celebration of the jubilee of the building in Sackville Street, the pamphlet includes two chapters intended to provide the general background to the proposals as well as one briefly sketching the development of the College and another discussing in general terms the teaching of science and technology to undergraduates. The first of these two chapters reviews the development of technological education in general and stresses how badly Great Britain compares to-day in facilities and in output of graduates in science and technology with other countries. Postgraduate degrees in science and technology in 1954 totalled 900, compared with 4,500 in the U.S.S.R. and 3,500 in the U.S.A. At roughly comparable standards, Dr. Bowden estimates the number of first degrees in pure science at 5,200, or 105 per million of population, and in technology at 2,800, or 57 per million of population; for the U.S.S.R. the corresponding figures are: in pure science, 12,000 and 56; in technology, 60,000 and 280; for the United States, 23,500 and 144; 22,500 and 137. For Western Germany the corresponding figures are 3,450 and 67; 4,450 and 86; for France, 1,760 and 41; 2,988 and 70; and for Switzerland, 215 and 44; 399 and 82. The second of these chapters sketches very briefly the organization of technological education abroad.

With this background, Dr. Bowden in his fifth chapter discusses the organization of university courses in Britain, commenting that students of the Manchester College of Technology are given the most specialized university courses in England, and that all the technological courses in England are more specialized than those in the rest of the world. Most of the courses in Manchester, he concludes, have grown up piecemeal and each department attempts

* Proposals for the Development of the Manchester College of Science and Technology. By Dr. B. V. Bowden. Pp. viii+140. (From the College.) 5s.

Fig. 1. The architect's drawing of the completed Manchester College of Science and Technology

to be independent of the result, with in consequence unnecessary duplication of lectures. Dr. Bowden criticizes the system as too inflexible and requiring thorough revision. Stressing the importance of industrial experience for students of technology, he does not advocate introduction of 'sandwich courses' for that purpose, but suggests the College should take the lead in organizing a new apprenticeship scheme. Dr. Bowden also emphasizes the need for post-graduate courses, both in science and in technology.

The most difficult task in the next ten years, in Dr. Bowden's view, will be to attract an adequate number of suitable staff. In 1954 the Manchester College of Technology had only four professors and six hundred university students; if the College is to attract 1,500 students in 1962 in place of the present 900, the ten professors of 1956 must be increased by at least twelve. He believes that senior staff should be encouraged to become industrial consultants and part-time members of the staff of such establishments as the Shirley Institute and leading industrial research establishments, and that local industrialists and senior members of such local research institutions should be elected honorary or industrial lecturers or professors. The practice of sabbatical leave is another respect in which the staff policy of the College requires improvement; and in recruiting staff, proper weight should be given to industrial experience as well as to teaching and academic research, while more attention should be given to studying the craft of teaching and experimenting with new methods. He also advocates placing senior specialists in charge of specialized subjects throughout the College. The postgraduate research school, at present numbering 170, should be considerably expanded, but should concentrate its resources on basic research and a limited number of objectives, so chosen as to produce some significant contribution to knowledge; nevertheless, it should also be organized so as to undertake more co-operative and sponsored research. Dr. Bowden hopes that the contract with the National Research Development Corporation for the development of certain machine tools will prove the prototype of many similar undertakings.

Before outlining his detailed expansion programme, Dr. Bowden stresses the importance of broadening the basis of the undergraduate curriculum, specifically so that students can understand and appreciate the profound impact that the growth of science and technology has had upon society. All students, he thinks, would profit greatly from studying the history of science, and particularly of technology, and he thinks that courses based on the history of technology might take in the College the role that has been traditionally cast for the humanities.

As regards the actual expansion, he suggests that the College should have room for at least 2,000 students before the 'bulge' in the student population arrives in 1965–66, and that at least another 1,000,000 sq. ft. of floor space will be required within the next decade. The present area is rather less than half that. The governors have consulted with the University Grants Committee and with the Planning Sub-Committee of the Manchester City Council, and the City has now decided to reserve an area of about 27 acres on the south side of the College for its ultimate use. Areas *A* and *C* will be reserved for an extension of the College on the understanding that the necessary amendment is made to the development plan in due course, and Area *B* will be regarded as reserved for future extensions; in the meantime, special consideration will be given to any proposals for major development in the area. The building programme should thus in due course transform a squalid slum into a new lung for the City.

Dr. Bowden advocates creation of new chairs in building, in structural engineering, in mathematics and in production engineering in 1956–57, and chairs in industrial statistics, in some aspect of electrical engineering, and perhaps in the Chemistry Depart-

ment in 1957–58. Aeronautical engineering he regards as possessing high claims, but these must be considered with the claims of other chairs when more is known as to the financial resources available from the University Grants Committee. When the conversion of the cotton mill is complete, it is hoped to build a block of lecture rooms and a new department of civil engineering, thus permitting a redistribution of space which will allow expansion of all departments. He suggests that a second vice-principal should be appointed to take charge of the Department of Industrial Co-operation, and looks to a Department of Polymer Chemistry to supplement the work done in the Textile Department as a whole, as well as to the rapid development of the Department of Industrial Administration and of a school of research in printing, particularly in association with photography.

OBITUARY

Prof. Frederick G. Donnan, C.B.E., F.R.S.

On a September day almost thirty years ago, a young man stood in front of the apple-green door of No. 23 Woburn Square in London, calling for the first time on the famous scientist to whose laboratory he had been attracted from five thousand miles away. The interview went on for some time while Prof. F. G. Donnan patiently persuaded the young man to give up the narrow field of physical chemistry that he had planned and to choose one which was broader and was expanding rapidly. But the young man's eagerness to start that afternoon was squashed by: "I don't think you should come into the laboratory for a week. First, get to know London past and present, visit its museums and art galleries, its theatres—just walk about and then tell me what you've learned—this time next week".

So began one person's story of Donnan which was to end a few weeks ago in Canterbury Hospital, where old age had taken him. Then, as always, his interest was in the London he loved, in the affairs and doings of the many people who could claim to be his friends. He died on December 16.

In September 1927 Donnan was fifty-seven years old. The high days of his own personal scientific achievements were past. The best-known one, his treatment of ionic equilibria across semi-permeable membranes, had long since become a foundation stone of modern physiology. The flood of honours was, however, in full swing. Details of these will no doubt appear elsewhere and will show the esteem in which his work was held, not only by his colleagues in the Royal Society—he was awarded the Davy Medal in 1928—but also by universities and scientific societies all over the world. For Donnan was one of the great men of physical chemistry in that era when this branch struggled to achieve its place alongside the two giants, inorganic and organic chemistry. Later, he helped this new branch to become the basic or unifying theme of all the chemistries, including biochemistry, that it is to-day. His work spanned the field of physical chemistry from chemical thermodynamics to colloids, making the former more useful and the latter more 'scientific'.

In 1927, the school of physical chemistry at University College was at its height. But it was not a school of the type where much of the activity is devoted to the development of the ideas of an agile and able man at the top. It was certainly bound around one man, or rather around a personality whose "greatest joy in life has always been the making and helping of young scientific men", to quote his own words. It was a school of many parts with scarcely a side of physical chemistry unrepresented. In the work and personal activities of all the eighty–ninety staff, fellows and research students, Donnan took an interest. He would with patience listen to the embryonic ideas of the inexperienced, and through questions gently explore a weakness or give a lead to fresh ideas. Somehow or other he skilfully avoided filling in the missing ideas himself but stimulated them in others. His name appears in the acknowledgments of hundreds of scientific papers, but in this period rarely as an author.

One of the outstanding characteristics of the school was its international character; research students came in continuous streams from every part of the world. This was partly because of the high esteem in which Donnan's work was held, but more because of the friendly relations he established abroad. He travelled extensively, and everywhere he was received in a princely manner and with affection. He was an international man, as his foreign secretaryship of the Chemical Society indicated. His extended help to the victims of Hitler is a measure of his interests and his sympathy.

No. 23 Woburn Square played a major part in every Donnan story. To it came people from all over the world for discussion not so much of science as of philosophy and 'many things'. To meet them were invited the young men and women of the College. For Donnan knew everybody that mattered in science and especially in industry, and he made it a pleasant duty to ensure that his students benefited by this. A studentship with Donnan was a passport to travels abroad. The path to a career in great firms like Imperial Chemical Industries was well signposted by him. In the reverse direction he persuaded industrialists to take an interest in universities and help them financially.

The hospitality in that home had an elegance and a quality that one imagined belonged to a bygone age. But its success was largely due to two sisters—Nora, who ran the house (she died in May 1956), and Jane, who organized things at his office and his home, and who predeceased him by only three days.

When Donnan retired in 1937, he progressively cut himself off from the whirl of the London scientific circle. Soon after the bombing of London started, the family moved to the charming Kentish village of Hartlip just off the Chatham–Sittingbourne road, where with his strong physique to help him, Donnan almost took on the new role of a country squire. A bomb destroyed the house in Woburn Square a week after the move.

His retirement was complete. Except to fulfil some of his continuing commitments such as for the Society for Visiting Scientists, and to attend special occasions such as the jubilee of the Faraday Society,

of which he was a founder member, he rarely came up to London. A very special occasion was the dinner given to him at University College by many of his old students on his eightieth birthday. Hundreds of his friends have kept in touch with him by letter or visits through the whole of his retirement.

Much remains to be said about this great man of science. An attractive and inspiring personality he certainly had. He was generous to a fault; his testimonials had to be heavily discounted. It was surprising to many that, while he could inspire self-confidence in others, he could not do the same for himself—perhaps the two are connected, for his sympathy and his generosity in praise might have sprung from a knowledge of what is needed by others. Religious?—certainly in the *de facto* sense but not *de jure*. A sense of humour—who will forget his speech at a student rag dinner when a famous French professor was given his 'presidential' chain of office which incorporated a chain commonly found (only) in English households. As a teacher even the second law of thermodynamics took on a new light. In short, a man that many would like to be able to emulate.

The bomb that fell in Woburn Square left standing only the apple-green door. There it stood for many years until it was demolished some months ago to make room for a new extension to the University of London. Perhaps it will be replaced by a blue plaque, "Donnan lived here". C. F. Goodeve

NEWS and VIEWS

Prof. S. Chandrasekhar

The award of the Rumford Premium of the American Academy of Arts and Sciences to Prof. Subrahmanyan Chandrasekhar for his researches on radiative transfer of energy in the interior of stars was recently reported in *Nature* (**179**, 77; 1957). This further recognition of the valuable work of one who has already received the Gold Medal of the Royal Astronomical Society and the Bruce Medal of the Astronomical Society of the Pacific will be welcomed by Prof. Chandrasekhar's many friends on the east side of the Atlantic. Proceeding to Cambridge in 1930 after graduating at the Presidency College, Madras, he was awarded his Ph.D. in theoretical physics, was elected to a fellowship at Trinity College, and later obtained the degree of Sc.D. in theoretical astrophysics. In 1936 Prof. Chandrasekhar went to the Yerkes Observatory; there and in the University of Chicago he has gathered around him an influential group attacking a wide field of research in theoretical astrophysics. The Rumford award refers to one side of his work, but the titles of his other books, "An Introduction to the Study of Stellar Structure" and "Principles of Stellar Dynamics", cover different fields in which he has developed important studies; his George Darwin Lecture on "Problems of Stability in Hydrodynamics and Hydromagnetics" shows how widely Prof. Chandrasekhar casts his net. In his mathematical work he has made many fundamental contributions to astrophysics.

Physiology at Middlesex Hospital Medical School: Prof. Eric Neil

Prof. Eric Neil, who has just been appointed to the John Astor chair of physiology at the Middlesex Hospital Medical School in succession to the late Prof. Samson Wright, was a student at the School of Medicine in Leeds, where he graduated in 1942. He obtained his M.D. in 1944 and was awarded his D.Sc. in 1953. During 1942–50 he was first demonstrator and then lecturer in physiology in Prof. Hemingway's department in Leeds. He was appointed senior lecturer in physiology in Prof. Samson Wright's department at the Middlesex Hospital Medical School in 1950, and became reader in 1953. Prof. Neil's research activities have been varied, but his most important contributions have related to blood gases, reflex control of the circulation, studies on the larynx and the physiological changes accompanying hypothermia. His early academic interest in oxygen and carbon dioxide dissociation curves in blood found an important practical application when he came to study the disturbances induced by hypothermia in cardiac surgery. He was the first to describe the severe metabolic acidæmia and the serious liver damage which may accompany this procedure. He has made many important contributions to the reflex control of the circulation and respiration using electrophysiological techniques to study the activities of baro- and chemo-receptors. Some of this work was done in conjunction with Prof. Y. Zotterman in Stockholm. Prof. Neil is at present writing a monograph with Prof. C. Heymans, of Ghent, on this subject.

Tribute to Prof. M. Saha

The issue of *Science and Culture* for October 1956 is a special number devoted to the late Prof. Meghnad Saha's activities in research, education and scientific organization. The issue contains ten articles by colleagues, friends and students of Prof. Saha, dealing with his contributions to astrophysics, nuclear physics and the development of atomic research in India, geophysics, calendar reform, river valley developments, and his success as a teacher and organizer. Prof. Saha's contribution to the Dr. D. M. Bose Seventieth Birthday Commemoration Volume of the *Transactions of the Bose Research Institute* (**20**, 109; 1955) was an account of the present position of nuclear reactor development, and it is fitting that in the special number Dr. Bose should pay tribute to Saha by an article suggesting how the atomic energy power programme in India should proceed. He maintains that of the many proposals now being discussed concerning the most suitable form of memorial to commemorate the outstanding services of the late Prof. Saha, nothing could be better than the erection of a nuclear reactor in the region served by the Institute of Nuclear Physics, Calcutta, the existence and present development of which are almost solely due to his efforts. Besides being an academic scientist who achieved international distinction by his theory of thermal ionization in solar and stellar atmospheres, Prof. Saha was responsible for a large number of extra-mural activities. He took the initiative in founding the National Academy of Sciences in India and became its first president in 1932, and in 1935 Prof. Saha became the first joint secretary of the National Institute of Sciences of

India, a body which he himself first suggested in his address as president of the Indian Science Congress Association meeting in Bombay in 1934.

Urology and Medical Physics at Leeds

THE Council of the University has accepted a gift of up to £60,000 from the Wellcome Trustees towards the cost of building research laboratories for medical physics and urology. The laboratories will be built on a site at the General Infirmary at Leeds, and it is expected that substantial contributions will be made by the United Leeds Hospitals Board and the University to meet additional costs of the building and its equipment. The total cost is expected to be about £120,000.

The Department of Urology in the teaching hospital, the General Infirmary at Leeds, was established in October 1950. At the same time, a Department of Urology was established in St. James's Hospital, Leeds, the two hospital departments co-operating to form one urological unit for the city, Mr. L. N. Pyrah being appointed consultant surgeon to the unit. In October 1956 the University appointed Prof. Pyrah to a personal chair in urological surgery—the first chair of its kind in Great Britain. The Medical Research Council accepted major responsibility for the research programme of the Urological Unit and helped in creating a clinical research unit for the study of urological and surgical metabolism under the honorary directorship of Prof. Pyrah, with Dr. F. M. Parsons as assistant director. The University Department of Medical Physics has developed from the earlier Physics Department in the General Infirmary at Leeds. The University Department was founded in 1950, to further the application of physical methods to clinical research: in collaboration with many departments of the teaching hospital, its work includes investigation of problems bearing directly on the treatment of patients. When established by the University in 1950, the chair of medical physics, to which Prof. F. W. Spiers was appointed, was the first chair of its kind in Great Britain outside London. The clinical work and research programmes of the Urological Unit and the University Department of Medical Physics have developed in increasingly close association, and have both been assisted by the financial support of the Yorkshire Council of the British Empire Cancer Campaign and the Leeds Regional Hospital Board as well as the United Leeds Hospitals Board and the University.

The Urological Unit has developed work upon problems which have included biochemical studies following certain operations for cancer of the bladder and other conditions for which deviation of the urinary stream is necessary, clinical and biochemical studies in cases of renal failure due to advanced kidney disease and severe cases of prostatic obstruction, and also cases of stones in the kidney; in August of last year an artificial kidney was provided by the Board of Governors of the Teaching Hospital for the treatment of the most serious cases of renal failure. In medical physics, extensive work has been done on the application of radioisotopes to medical problems, frequently jointly with the Urological Unit on problems mentioned above. In addition, work is being done on the development of electronic methods as a means of providing better methods of measuring and recording the small electrical signals occurring in muscle and brain; and, in another field, electronic scanning, as in a television camera, is being applied to intensify the X-ray screen image. The Department has developed a special interest in the measurement of body radioactivity, and the first international conference on this subject was held in Leeds in April 1956. With the sensitive apparatus now at the Department's disposal, it is possible to detect any small excess activity which may have been acquired occupationally or in other ways—an important safeguard in the development and use of new radioactive materials. The Department has devoted much research also to the physical aspects of X-ray and radium therapy, and the results of its investigations on radiation absorption in bone have been widely applied in radiological work. Thus, these programmes of work in urology and medical physics together underline a development which is becoming increasingly a feature of modern medicine—the growth of an extremely close partnership between the medical man in his concern with clinical research upon disease in the patient, and the scientist in his primary concern with fundamental physical, chemical and biochemical problems.

Hungarian Refugee Students

THE Senate of the University of London has made available £1,000 for the immediate operation of 41 Tavistock Square as a reception centre for refugee Hungarian students. The house was cleaned and partly redecorated by students of the University and furniture has been obtained on loan from the London Hostels Association. Similar arrangements have been made in 12 Princes Gardens, which the Imperial College of Science and Technology has organized as an annexe to 41 Tavistock Square to accommodate sixteen students. The Senate on December 19 voted a further £1,000 to cover the needs of both centres for the immediate future. Fifty-five Hungarian refugee students are temporarily accommodated at 41 Tavistock Square, 12 Princes Gardens, Canterbury Hall, College Hall and Nutford House.

The universities of Britain have agreed to accept and maintain one hundred and fifty Hungarian refugee students. London's share is thirty-four. The Senate has approved a scheme for registration of refugee students from Hungary who provide satisfactory evidence of a qualification to matriculate in a university or institution of equivalent rank, and who have been prevented from pursuing courses of study or have suffered interruption in their courses through political circumstances.

Synthetic Detergents

THE Standing Technical Committee on Synthetic Detergents, the formation of which was announced in the House of Commons by the Minister of Housing and Local Government on December 18, has now been appointed, in consultation with the Secretary of State for Scotland, with the following membership: *Chairman:* H. W. Cremer, partner in the firm of Cremer and Brearley, consulting chemical engineers; *Members:* Dr. N. R. Beattie, principal medical officer, Ministry of Health; Dr. E. A. B. Birse, chief inspector of alkali works and rivers pollution in Scotland; Dr. A. H. Cook, assistant director, Brewing Industry Research Foundation; H. R. Galleymore, head of research and development, Thomas Hedley and Co., Ltd.; W. E. Hamer, general research manager, Monsanto Chemicals, Ltd.; Dr. G. C. Hampson, research manager, Unilever, Ltd., Port Sunlight; Dr. S. H. Jenkins,

chief chemist, Birmingham Tame and Rea District Drainage Board; Dr. A. Key, senior chemical inspector, Ministry of Housing and Local Government; Dr. J. Longwell, senior principal scientific officer, Department of the Government Chemist; F. T. K. Pentelow, chief inspector of salmon and freshwater fisheries, Ministry of Agriculture, Fisheries and Food; Dr. B. A. Southgate, director of water pollution research, Department of Scientific and Industrial Research; R. C. Tarring, manager of Detergents Department of Shell Chemicals, Ltd.; Dr. E. Windle Taylor, director of water examination, Metropolitan Water Board; *Secretary:* D. H. A. Price, Ministry of Housing and Local Government.

The Committee has the following terms of reference: "To keep under review the difficulties, or risks of difficulty, arising in sewage works, rivers and water supply as a result of the use of synthetic detergents; to encourage, and assist the co-ordination of, appropriate research by manufacturers of detergents and intermediate materials, and by suitable public bodies, into methods by which those difficulties, or risks of difficulty, could without an undue burden on public funds be avoided or overcome; and to report progress at least once a year."

Presentation of the Corner Collection to the British Museum (Natural History)

Dr. C. T. Trechmann has recently purchased and presented to the British Museum (Natural History) the greater part of the late Dr. Frank Corner's collection of early human skulls and other skeletal remains, including the famous Galley Hill skeleton which has been the subject of controversy for nearly seventy years. The Galley Hill skeleton is that of a man of modern type, that is, *Homo sapiens*, but with certain so-called primitive traits; it was discovered in 1888 at a depth (it is said) of 8 ft. in the ancient gravels of the River Thames at Swanscombe near Dartford. These gravels contain flint hand-axes at the earliest stone age, and bones of extinct rhinoceros and elephant. If this human skeleton were really contemporaneous with the gravel as the original investigators claimed, it would be older than Neanderthal man, and by far the oldest known skeleton of our own species. After the Swanscombe skull was found during 1935–36 in the same gravels but at a depth of 24 ft., interest in the Galley Hill skeleton revived, for the new skull seemed to foreshadow modern man, and its antiquity was beyond doubt. However, in 1948, comparison of the fluorine content of the Galley Hill skeleton with that of extinct animal bones from the Swanscombe gravels left no doubt that it was an intrusive burial of comparatively late date, possibly Neolithic. The same test confirmed the antiquity of the Swanscombe skull. More recently these results were reinforced by measurements of nitrogen content.

Field Studies Council

In order to meet the steady increase in the demand for places, the Field Studies Council has decided to open a fifth Field Centre at Preston Montford, near Shrewsbury. This Centre will be opened in the spring and is well situated to take full advantage of the many and varied opportunities for field work which Shropshire offers, not least in the geographical and geological spheres. The Council hopes that the opening of the Centre will be the means of enabling bookings to be offered to those who have so often, in recent years, been unable to obtain all the places they require at existing Centres. Besides courses in geographical and geological studies, Preston Montford is offering special countryside courses for school and university groups as well as rural science courses for teachers. Among the many interesting courses at the five established Centres is one on insects at Malham Tarn and another on snails at Juniper Hall. Besides insect ecology, Flatford Mill offers, *inter alia*, interesting courses on animal life in the soil, landscape painting and spiders, while a course at Dale Fort in practical archæological excavation which is to be led by Prof. W. F. Grimes should quickly be over-subscribed. Opportunities for bird studies are again being made available at Skokholm. Inquiries should be addressed to Ravensmead, Keston, Kent.

The National Museum of Canada

The annual report of the National Museum of Canada for 1954–55 (pp. 180+20 plates. Ottawa: Queen's Printer, 1956. 1.50 dollars) records that twenty-two field projects were undertaken during the summer season covering palæontological, zoological, botanical, archæological and ethnological studies. In addition, four Museum bulletins were issued, many exhibits were improved and two large murals, one of moose and the other of the barren ground caribou, were completed. As usual, the report includes several original papers and also embodies, as a special feature, a bibliography of Canadian anthropology, archæology and ethnology for the year 1954.

Zoological Nomenclature

The International Commission on Zoological Nomenclature gives notice that as from May 30 it will start voting on the following case involving the possible use of its plenary powers for the purpose specified; full details have been published in the *Bulletin of Zoological Nomenclature* (**12**, Pt. 11): Pieridae Duponchel, 1832, validation of family-group name (Cl. Insecta, Order Lepidoptera). In addition, applications for the use of the plenary powers in the following cases were published in the *Bulletin* (**11**, Pt. 12): (1) *Ptychopyge* Angelin, 1854, designation of type species (Cl. Trilobita); (2) *convexa* de Haan [1835] (*Ocypode* (*Chasmagnathus*)) validation (Cl. Crustacea, Order Decapoda). Comments should be sent as soon as possible and in duplicate to Francis Hemming, Secretary to the Commission, 28 Park Village East, Regent's Park, London, N.W.1.

Host-specificity and Parallel Evolution

A symposium on host-specificity and parallel evolution among parasitic insects and worms of vertebrates, under the chairmanship of Dr. Ernst Mayr (Harvard), will take place at Neuchâtel (Switzerland) during April 15–18. The aim is to bring together both parasitologists and specialists of the host groups to discuss the various problems that have been tentatively grouped under the following headings: adaptation, dispersal, speciation and phylogeny. The following have agreed to present reports or to take part in the discussion. On hosts: L. Harrison Matthews (London), Kuhn-Schneider (Zurich), A. J. Marshall (London), B. Patterson (Harvard), E. Stresemann (Berlin); On parasites: J.-G. Baer (Neuchâtel), A. Chabaud (Paris), Th. Clay (London), G. Dubois (Neuchâtel), L. Euzet (Montpellier), Y. Golvan (Paris), G. Hopkins (Tring), W. Inglis (London), N. Kent (Baltimore), J. Llewellyn (Birmingham), H. W. Manter (Lincoln, Neb.), O.

Theodor (Jerusalem). It is intended to have all the reports ready beforehand in either mimeographed or printed form so as to avoid translations and to leave more time for discussions. This symposium is being held under the auspices of the International Union of Biological Sciences and the University of Neuchâtel. Further particulars may be obtained from the general secretary, Prof. Jean G. Baer, C.P.2, Neuchâtel 7 (Switzerland).

Oversea Service Division : Colonial Office

THE following appointments have recently been made in the Oversea Service Division, Colonial Office: E. G. McAnulty (laboratory technician, Uganda), chief laboratory technologist, Department of Veterinary Services, Uganda; G. R. Scott (veterinary research officer, Kenya), senior virologist, East African Veterinary Research Office, East Africa High Commission; C. J. R. Bridge, agricultural officer, North Borneo; G. D. N. Clark, adviser on land policy, British Guiana; A. C. Dennison, temporary principal agricultural officer, Northern Nigeria; D. M. Dring, specialist, plant pathologist, Agricultural Department, Gold Coast; B. Gietema, agricultural officer, Gold Coast; Dr. R. G. Hurd, plant physiologist, Gold Coast; P. C. Lloyd, land research officer, Western Nigeria; A. L. Moore, agricultural engineer, Department of Agriculture, Gold Coast; J. Rossiter, specialist officer (plant breeder), Northern Nigeria; S. G. Willimott (formerly senior chemist (soils), Federation of Malaya), temporary acting director, West African Institute of Oil Palm Research, Nigeria; K. W. Brown, forest entomologist, Department of Forests, Uganda; J. D. Leefe, assistant conservator of forests (class 1, education officer), Cyprus; G. S. Carter, geologist, Tanganyika; A. N. Hutton, geologist, Geological Survey Department, Gold Coast; J. L. Clarke, entomologist, Medical Department, Western Nigeria; J. D. M. Marr, entomologist, Ministry of Health, Gold Coast; W. A. McDonald, temporary senior scientific officer, research entomologist, West African Institute for Trypanosomiasis Research; M. A. Vickars, scientific officer (chemist), Colonial Insecticides Research Unit, Arusha, Tanganyika; K. L. Strickland, veterinary investigation officer, Northern Nigeria; J. B. Dundas-Taylor, veterinary research, Nyasaland; P. G. Fenemore, entomologist, British Solomon Islands Protectorate; G. W. Heath, entomologist, Nyasaland.

Announcements

SIR ARTHUR WHITAKER has been elected president of the Institution of Civil Engineers in succession to the late Mr. H. J. F. Gourley. Sir Arthur was for many years civil engineer-in-chief, Admiralty, and is now a partner in the firm of Livesay and Henderson (consulting engineers).

PROF. C. K. INGOLD will deliver the Pedler Lecture of the Chemical Society on "The Course of Polar Reactions in Non-polar Conditions" at the Royal Institution on February 14 at 7.30 p.m. Inquiries should be addressed to the General Secretary, Chemical Society, Burlington House, London, W.1.

DR. T. E. ALLIBONE will deliver the Faraday Lecture of the Institution of Electrical Engineers at the Central Hall, Westminster, on February 13 at 6 p.m., his subject being "Nuclear Energy in the Service of Man". Admission is free by ticket, obtainable from the Institution, Savoy Place, London, W.C.2.

THE Shell Petroleum Company has made a donation of £20,000, payable by covenant over seven years, to the University College of North Staffordshire.

THE conditions of the Structural Aluminium Research Scholarship administered by the Institution of Structural Engineers have been revised and it is now open for award every third year for a two-year period, the value of the Scholarship being £600 per year. Entries for the Scholarship, which is intended to enable the holder to undertake research on some aspect of the application of aluminium alloys to structures, close on March 31. Further particulars, together with forms of entry, can be obtained from the Secretary of the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1.

THE fourth display of instruments organized by the Scientific Instrument Manufacturers' Association opened on January 2 at SIMA House, 20 Queen Anne Street, London, W.1, and will continue for three months.

THE Third International Instrument Show, sponsored by B. and K. Laboratories, Ltd., and Allied International Co., Ltd., will be held at Caxton Hall, London, during March 25–29. More than fifty leading instrument manufacturers from the United States, Switzerland, Western Germany, Denmark, Holland, Sweden, Austria and Great Britain will be displaying some three hundred items of test equipment and apparatus. Tickets can be obtained from B. and K. Laboratories, Ltd., 57 Union Street, London, S.E.1.

THE tenth congress of the Laboratory Animals Bureau is to be held at the Royal (Dick) School of Veterinary Studies, Edinburgh, during April 4–5. Further information can be obtained from the Laboratory Animals Bureau, M.R.C. Laboratories, Holly Hill, Hampstead, London, N.W.3.

A TWO-DAY symposium on "Antioxidants in Foods" is to be held in Cambridge during April 2–3. Further information and registration forms (to be returned by March 4) can be obtained from Dr. C. H. Lea, Low Temperature Research Station, Cambridge.

THE fourth Easter symposium on agricultural science at the University of Nottingham School of Agriculture, Sutton Bonington, will be held during April 15–17. The symposium will be devoted to a study of the ways in which the plant environment can be controlled to facilitate experimental work, and the uses which can be made of environmental control in the study of plant behaviour. The possibilities of increasing crop yields by stricter control of environment in the field or glasshouse will also be discussed. Further information can be obtained from Prof. J. P. Hudson, School of Agriculture, University of Nottingham, Sutton Bonington, Loughborough.

The ninth Technical Exhibition of the Oil and Colour Chemists' Association will take place during March 12–14 at the Royal Horticultural Society's new hall, Greycoat and Elverton Streets, London, S.W.1. The theme of the Exhibition will be the presentation of technical advances in those industries supplying the paint, varnish, printing ink, linoleum and allied industries, and there will be 87 companies and research associations exhibiting. There will be no charge for admission or for the descriptive brochures, which can be obtained from the General Secretary, Mr. R. H. Hamblin, Oil and Colour Chemists' Association, Memorial Hall, Farringdon Street, London, E.C.4.

THE INTERNATIONAL COMMITTEE ON LABORATORY ANIMALS

MORE and better laboratory animals are to-day required than ever before, and this demand will continue to rise if it is to keep pace with the quickening tempo of biological, medical and veterinary research. The provision of this living experimental material is no longer a local problem; local, that is, to the research institute. It has become of national concern and, in some of its aspects such as strain nomenclature, even international. It is encouraging, therefore, to see it being considered internationally.

At a meeting of consultants called by Unesco in Paris during December 3–4, 1956, there was general agreement that a body should be formed to help solve problems arising from the increasing use of laboratory animals. As a result, an International Committee on Laboratory Animals has been set up, under the auspices of the International Union of Biological Sciences and the Council for International Organizations of Medical Sciences, with the assistance of Unesco. The Council for International Organizations of Medical Sciences includes in its membership the International Union of Physiological Societies, the International Union of Biochemistry and the International Union against Cancer.

Two independent activities had preceded this event. The first in time was the appointment of an international committee by the International Union of Biological Sciences, which arose out of a resolution adopted at its meeting in Rome in April 1955. The second was the request by Unesco for information about the production and use of laboratory animals in various countries; this was part of the cell biology programme recommended by the Council for International Organizations of Medical Sciences in December 1955. Both these activities have been taken over by the new committee.

The International Committee on Laboratory Animals consists of: (*a*) a representative of the International Union of Biological Sciences, Prof. Sven O. Hörstadius, who is president of the Union (chairman of the Committee); (*b*) a representative of the Council for International Organizations of Medical Sciences; (*c*) Dr. Dale W. Jenkins, chairman of the Institute of Laboratory Animal Resources, National Academy of Sciences—National Research Council, U.S.A.; (*d*) Dr. W. Lane-Petter, director of the Laboratory Animals Bureau, Medical Research Council, United Kingdom, honorary executive secretary of the committee; (*e*) M. M. Sabourdy, directeur du Centre de Sélection des Animaux de Laboratoire, Centre National de la Recherche Scientifique, France; and (*f*) a representative of Unesco.

The aim of this Committee is to find out what must be done to ensure that experimental biology and medicine are not hindered by a lack or shortage of suitable animals. To begin with, a survey of existing resources must be made, in order to obtain a reasonably accurate picture of supply and demand. Arrangements to survey sources and consumption of animals have already been made in the Benelux countries, France, Italy, Scandinavia including Finland and Iceland, United Kingdom and United States of America, and further countries are to be added as opportunity arises. The Committee receives financial support from the International Union of Biological Sciences and from the Council for International Organizations of Medical Sciences. Unesco is assisting substantially by placing contracts with individuals for the initial survey; by calling meetings of the Committee and providing travel grants; by much administrative help; and in time to come by printing the results of the Committee's work.

From analysis of the surveys further action will naturally develop, but among the earlier objectives of the Committee are the definition of common terms used in relation to laboratory animals, with regard to genetics, disease and parasitism, nutrition, care, performance; the compilation of a world list of strains of laboratory animals; the selection of suitable centres for the production of animals achieving a high and defined quality, or for the maintenance of master stocks of such animals; the recognition of problems which do, or are likely to, interfere with the supply of suitable animals and the action needed to forestall them; and the investigation of customs, quarantine and other regulations governing the international shipment of laboratory animals. The Committee will also examine the need for establishing an information exchange on laboratory animals; for laying down standards of education and training for animal technicians; for creating internationally recognized standards for laboratory animals and for testing animals claimed to attain such standards; and for furthering the dissemination of knowledge of this subject, possibly through symposia or congresses.

Some of these activities have already been started by national organizations, and the new Committee will lean heavily on the accumulated experience in different countries. The Laboratory Animals Bureau in the United Kingdom, formed in 1947 by the Medical Research Council, has already conducted a detailed survey in Britain[1]. The technique of this survey, and its analysis and presentation, may be taken as a model, subject to modification appropriate to other countries. The Institute of Laboratory Animal Resources in the United States, formed in 1952 by the National Academy of Sciences—National Research Council, has done similar work and published a "Handbook of Laboratory Animals"[2]. Its present activities are numerous, but among them may be mentioned the determination of standards for certain types of laboratory animals, which will also be a model for the International Committee. The Centre de Sélection des Animaux de Laboratoire in France, among other activities, is building up a repository of master strains of animals from which producers—commercial or laboratory—can draw breeding stocks.

Most of the work has yet to be done in regard to definitions, logistics and care of laboratory animals, and it should be done internationally. Animals must be defined as to quality, but if the definitions are esoteric, local or ambiguous they will soon cease to have any meaning. Such has been the fate of the 'Swiss' mouse, for those labelled 'Swiss' may to-day be no more than albino, and albinism can cover a multitude of genes. As a result of the new Committee's work, the experimental biologist can look forward to being able to state precisely what animals he has

used or wishes to use, in terms that are universally accepted, so that his colleague in another continent will know immediately the nutritional requirements, the state of freedom from specific infection, the pedigree and the possible sources of the same strain.

The quality of the animals sooner or later limits all work for which they are used. Cancer workers were among the first to realize this, and much of their research would to-day be impossible without the highly defined strains of mouse and rat being used. In the field of bio-assay the amount of frustrated effort resulting from the use of inadequate animals can only be estimated by the minority who have taught themselves, if not their colleagues, the value of good ones. But it is of little benefit to swell the minority into a majority unless, first, there is agreement on the definition of quality and, second, the better animals can be produced in sufficient numbers. The first of these provisos is a matter for the International Committee. Those who hold the purse strings of research can facilitate the second by taking the laboratory animal from the bottom of the list of claims and placing it somewhere near the top. Lastly, the research worker himself can give decisive support by insisting on being provided with better animals, and making good use of them when he gets them.

W. LANE-PETTER

[1] See *Brit. Vet. J.*, **111**, 282 (1955).
[2] See *Nature*, **175**, 26 (1955).

GAS CHROMATOGRAPHY

A SYMPOSIUM on gas chromatography, organized by the Hydrocarbon Research Group of the Institute of Petroleum, was held in London during May 30–June 1. The meeting was attended by nearly four hundred members from thirteen different countries, and the thirty-four papers presented covered all aspects of gas chromatography. The full proceedings, complete with discussion, will be published by Messrs. Butterworths shortly. It was felt that in this rapidly growing field, nomenclature and methods of presentation of data should be standardized as early as possible. A special Committee was accordingly nominated, comprising Dr. A. J. P. Martin (chairman), Mr. C. S. G. Phillips (secretary), Mr. D. H. Desty, Dr. E. Glueckauf, Dr. A. T. James and Dr. A. I. M. Keulemans. At the end of the symposium the chairman presented the Committee's recommendations, which were as follows.

Nomenclature

(*a*) That the term 'gas chromatography' be used to describe all chromatographic methods in which the moving phase is a gas, and that the term 'vapour phase chromatography' be no longer employed.

(*b*) That the term 'gas–liquid chromatography' be used to describe all gas chromatographic methods in which the fixed phase is a liquid (distributed on an inert support).

(*c*) That the term 'gas–solid chromatography' be used to describe all gas chromatographic methods in which the fixed phase is a solid (for example, charcoal, zeolites).

(In this report the Committee uses the term 'chromatography' only where a fixed phase is involved.)

Presentation of Retention Values in Gas–Liquid Chromatography

Since for many purposes it is unnecessary to determine absolute retention volumes, and since, by the use of an internal standard the corrected retention volume per gram of liquid phase of which has been measured, all values can be compared, it is recommended:

(*a*) That the retention values (retention volumes or retention times of concentration maxima) should be expressed relative to an internal standard; that in presenting values for a series of substances, the internal standard substance should be chosen so as to have a retention value near the middle of the series; that internal standards with very low retention values should not be used; that retention values should be corrected for dead-volume (by injection of a permanent gas) before these values are expressed relative to the internal standard; that such results should be quoted with the exact composition of the fixed liquid phase, the nature of the support material, and the exact temperature at which the column has been operated; that column temperatures be controlled by means of vapour jackets or circulating-fluid (liquid or air) jackets. It is felt that results obtained with a column which varies in temperature (along its length, or during the course of a run) will be of little value.

(*b*) That whenever possible the corrected retention volumes per gram of liquid phase (that is, V_g values) should be measured for the internal standard, careful corrections being made for the pressure drop across the column. These values may be obtained by the following procedure:

(1) Determine the volume of gas (measured at the exit pressure of the column, and corrected to dry gas at the column temperature) which has passed from the column between the emergence of the dead-volume (permanent gas) peak maximum and the peak (concentration) maximum of the internal standard.

(2) Correct this volume for the pressure drop across the column by multiplying it by the reducing factor

$$\frac{3}{2} \cdot \frac{(p_1/p_0)^2 - 1}{(p_1/p_0)^3 - 1}$$

where p_1 is the pressure at the beginning of the column, and p_0 the pressure at the exit. The values of p_1 and p_0 should be recorded.

(3) Divide the corrected retention volume so obtained by the weight (in grams) of the fixed liquid phase.

The Committee has envisaged the possibility that the measurements in sections (*a*) and (*b*) may sometimes be made by different workers. Attention is directed to the need, in connexion with the corrected retention volume, of accurate measurements of flow *rate. It is not considered that rotameter readings* are of sufficient accuracy for this purpose, and the use of soap-bubble or capillary flowmeters is suggested.

(*c*) That the following substances should be used *as internal standards: n-butane; iso-octane (2 : 2 : 4-*trimethylpentane); benzene; *para*xylene; naphthalene; methylethyl ketone; *cyclo*hexanone; *cyclo*hexanol.

(*d*) That in presenting retention values for new substances, one or more of the following liquid phases

should be used (temperature ranges (°C.) in parentheses): *n*-hexadecane (20 to 50); squalane (20 to 150); benzyldiphenyl (80 to 150); dinonyl phthalate (20 to 100); dimethylformamide (−20 to 20); diglycerol (20 to 100).

(It is hoped that these liquids will be made available in standard purity.)

That while it will be of great value if studies are made on the effects of varying the support material and the packing ratio, a mixture of 20 parts by weight of fixed liquid to 80 parts by weight of inert support (preferably 'Celite 545') be used as a standard.

(*e*) That with skew peaks the results for retention values should be extrapolated to zero sample size.

In drawing up these recommendations the Committee has in mind low-temperature (up to 150° C.) columns. It is felt that the subject of high-temperature (operated at above 150° C.) columns is not sufficiently developed to put forward rigid proposals.

Column Resolution

That column resolution be expressed in terms of theoretical plate numbers; that a theoretical plate number should always refer to a particular substance, and that the theoretical plate number of the internal standard should always be given. It is recommended that theoretical plate number should be determined by the following procedure: tangents (see Fig 1) are

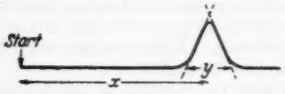

Fig. 1

drawn to the peak at the points of inflexion. The lengths of base line (y) cut out by these two tangents is then measured. The length from the start of the run (that is, including dead-volume) to the middle of this base-line section (x) is also measured. Then number of theoretical plates $= 16\,(x/y)^2$.

Vapour Detectors

In view of the often widely different performance characteristics of the detectors now used in gas chromatography, the Committee does not feel that it would be desirable at this stage to lay down any definite rulings on the manner in which detector sensitivities should be expressed. However, it wishes to emphasize that in describing detector performance attention should be paid to the following:

(*a*) The sensitivity should be expressed in terms of vapour concentrations rather than sample size. Details should always be given of the stability (under normal rather than favourable working conditions) of the base line, both for short periods (noise) and for long periods (drift). The sources of these instabilities should be indicated wherever possible (thus the effects of vibration may be more serious under some working conditions than under others).

(*b*) Linearity of response.

(*c*) Necessity for calibration.

(*d*) Response time and volume of detector.

(*e*) Reproducibility.

(*f*) Temperature-range of operation.

(*g*) Range of vapours, stressing types of vapour for which the detector is particularly suited or unsuited.

It is intended to form a discussion group for gas chromatography under the auspices of the Hydrocarbon Research Group in the near future, which will be responsible for holding further meetings as required and also for implementing the above recommendations, particularly as regards the collection, assessment and distribution of retention volume data.

D. H. Desty

CENTRAL ELECTRICITY AUTHORITY

REPORT FOR 1955–56

THE eighth annual report and statement of accounts of the Central Electricity Authority, which covers the year ended March 31, 1956*, is of particular interest for its reference to the contribution of nuclear power plant. At March 31, 1956, the Authority owned 274 power stations, with a total installed generating capacity of more than 20·6 million kW., there being a net increase in maximum output capacity of about 1·5 million kW. during the year, and a further increase of 45 per cent is planned during 1956–61. The 1961 programme of plant approved during the year is for 2,379,000 kW., of which 250,000 kW. is of nuclear plant, and consent was given in July 1956 to the establishment of such stations at Berkeley, Gloucestershire, and Bradwell-on-Sea, Essex. Competitive designs for these first two stations, of a capacity of not less than 150,000 kW., are being prepared by each of four industrial groups, and the greater part of the cost of electricity from such stations is expected to arise from capital charges. Stress is laid in the report on the severity of the requirements for siting such stations, twelve of which are included in the Authority's programme for the next ten years. Arrangements have also been made for the supply of heavy fuel oil to seventeen power stations, and it is estimated that the total consumption of oil will rise to more than 5·5 million tons a year, equivalent to some 9 million tons of coal, while one of two hydro-electric projects to receive Parliamentary sanction is a 300,000-kW. pumped storage scheme in North Wales, the first of its kind in Great Britain. With the introduction of nuclear power plant on a large scale for base-load operation, other new plant must be flexible in operation and suitable for two-shift workings and daily starting-up and shutting-down as required, and new 200,000- and 120,000-kW. reheat units are being designed accordingly. The Authority continues to be the largest individual user of coal in Great Britain and in 1955–56 consumed 41·04 million tons of fuel (39·87 million tons of coal), or 6·6 per cent more than in the previous year, with a 9·4 per cent increase in the electricity generated.

The main research laboratories of the Authority are at Leatherhead, and are occupied mainly with problems relating to the design and operation of power stations, including the efficient combustion of coal, the causes of boiler fouling and corrosion and methods of alleviation, particularly the fouling effects of certain coal constituents, the use of electronic equipment in studying operational problems, and, in co-operation with the Forest Products Research

* Central Electricity Authority. Eighth Report and Statement of Accounts for the Year ended 31st March, 1956. Pp. viii+244+8 plates. (London: H.M.S.O., 1956.) 10*s.* 6*d.* net.

Laboratory and the manufacturers of timber preservatives, the causes of breakdown in timber used in cooling-tower packings. A preservative treatment has been adopted which appears to be effective against the most prevalent form of fungal attack, and very sensitive and accurate methods of analysing boiler feed water for dissolved oxygen and for copper and iron have been worked out. Advantage was taken of the dry summer of 1955 to measure the rate of cooling of selected rivers affected by the discharge of circulating water, and research was also carried out into the measurement and amounts of temperature variations of steam and metal in power-station plant.

The Authority continued to support the work of the Building Research Station on the sintering process by which the fine ash from power stations is converted to aggregate and used in brickmaking. Blending of coals with a chlorine content of 0·5 per cent or more proved successful in further trials, and studies in air pollution have shown that a modern power station has no significant effect on ground-level pollution in the surrounding district. Research on utilization has also continued to expand, and the Authority, besides its membership of the British Electrical and Allied Industries Research Association, the British Coal Utilization Research Association, the British Hydromechanics Research Association, the British Welding Research Association, the British Non-Ferrous Metals Research Association and the British Iron and Steel Research Association, contributes to the work of the Ministry of Fuel and Power on the development of coal-fired gas turbines, and sponsored specific research in some fourteen universities and university colleges through its Committee on Research in Universities, which examines proposals submitted by the Electricity Supply Research Council.

COMMONWEALTH OF AUSTRALIA SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

REPORT FOR 1954–55

IN the sixth annual report of the Commonwealth of Australia Scientific and Industrial Research Organization for the year ended June 30, 1954, attention was again directed to the difficulties experienced by the Organization in recruiting first-class scientists. At the beginning of the year there were vacancies for 112 research officers, for which posts the minimum requirement is a good honours degree, and there was a net gain of only three in the year. Recruitment of technical officers, however, was satisfactory. Following increases in research salaries, the seventh annual report* records some improvement in the position up to June 1955, and although the net increase in research staff on the year was only twenty-three there was a considerable improvement in recruiting during the last months.

The Australian Atomic Energy Commission has now taken over the work of the Atomic Physics Investigation Unit at the University of Melbourne and also that of the Organization's officers at Harwell. The Section of Meteorological Physics has been designated a Division, and the administration of the Irrigation Research Stations at Griffith and Merbein has been placed under one direction. A third co-operative industrial research organization, the Australian Wine Research Institute, was established by the Wine Research Act, 1955, and during 1954–55 further research projects were sponsored on a co-operative basis. These include investigations by the Division of Building Research of defects in the decoration of fibrous plaster; by the Division of Industrial Chemistry of the extraction of uranium from unfiltered ore pulps; by the Animal Genetics Section of the breeding of mice sensitive and insensitive to œstrogens given subcutaneously; by the Division of Radiophysics on cloud-seeding; a study of marine fouling by the Division of Fisheries; and of cheese-making by the Dairy Research Section.

The availability of water supplies is probably the greatest natural limiting factor in the Australian environment, and the seventh annual report directs attention to two developments in the Organization's work bearing on this problem, now reaching the stage of large-scale tests. The detailed study since 1947 of the properties of single clouds by the Division of Radiophysics has demonstrated the important part in atmospheric condensation played by nuclei, and has also indicated how, under appropriate conditions, individual clouds can be made to rain by supplying substitutes when the natural nuclei are absent or ineffective. During the past year the emphasis has shifted to a search for more detailed information on the occurrence and behaviour of natural nuclei and on the investigation, supported by field trials, of methods of artificial seeding by which rainfall might be increased over a relatively wide area.

The preliminary work by the Division of Industrial Chemistry on the use of cetyl alcohol to retard evaporation of water from dams and open reservoirs has been so encouraging that, during the summer of 1954–55, trials were performed on stretches of water from one to three hundred and twenty acres in area. Both projects hold promise of significant returns in relation to the availability of water supplies.

Several important arrangements were made with universities during the year for the integration of research projects. Certain aspects of the work of the Timber Mechanics Section of the Division of Forest Products will be undertaken in the Engineering School, University of Western Australia, and the high-speed electronic computer constructed in the Division of Radiophysics is being transferred on permanent loan to the Department of Applied Mathematics, University of Melbourne, which will also receive a grant of £3,000 per annum for the maintenance of a mathematical computing centre. It has also been agreed to link closely pastoral research by the Regional Pastoral Laboratory at Armidale and the University faculty of rural science at New England. The University of Adelaide is providing accommodation for the Clay Mineralogy Section of the Division of Soils until the Division's new building is available. A grant for five years has also been made to the University of Adelaide for the establishment of an Animal Ecology Unit. The Organization has received a gift of 250,000 dollars from the Carnegie Corporation of New York towards the construction of a giant radio-telescope in Australia, for which the Commonwealth Government afterwards offered half the cost.

* Seventh Annual Report of the Commonwealth Scientific and Industrial Research Organization for the year ending 30th June, 1955. Pp. 185. (Canberra: Government Printer, 1956.) 11s.

Expenditure during the year totalled £5,449,643 compared with £4,861,873 in 1953–54. Of this, £554,858 was spent on plant problems, £533,061 on animal health and production problems, £439,850 on industrial chemistry, £429,661 on the National Standards Laboratory, £275,441 on radiophysics, £266,812 on wool textile research, £240,654 on forest products problems, £179,423 on food preservation and transport problems, £168,400 on entomological studies, £147,183 on fisheries investigations, £57,587 on mathematical statistics, £119,068 on building research, £116,626 on fuel research, £105,692 on land research and regional survey, £102,108 on biochemical and general nutrition studies, £161,433 on soil problems, as well as £91,891 on soils and problems of irrigation settlements, and £83,117 on wildlife survey. £71,591 was allocated to tribophysics, £53,671 to meteorological physics, £42,615 to dairy research, £33,237 to plant fibre research and £27,834 to genetics.

As in the immediately preceding annual reports, the material is arranged according to subject, rather than according to the Divisions or Sections concerned. Besides a full list of staff and personnel of the Council and Committees, there is an index of papers published during the year, arranged according to sections. The Division of Soils is the central body engaged in soil research in Australia and, besides systematic mapping of Australian soils in broad categories, more detailed classification and mapping of soils in specific areas, applied research into soil fertility and on soil mechanics, undertakes fundamental research on the pedology, chemistry, physics, mineralogy and microbiology of Australian soils. Considerable advances have been made in the study of the mineralogy of both clay and the coarser fractions as a guide to soil classification, the genesis of soil profiles, and as a useful attack on the geochemistry of the soil which may enter into fertility problems. Besides the X-ray studies, emphasis is being placed on the petrographic study of the non-clay fraction, and a new section dealing with clay mineralogy has been set up. The approach to microbiological studies has been broadened with the commencement of work on humus and on the nature and activity of organisms in the rhizophere immediately adjacent to the roots.

As part of a long-term programme of investigations of basic importance to plant introduction work in Australia, studies were begun at Canberra on problems of drought resistance and seasonal dormancy in introduced plants. In connexion with biophysical work at the University of Tasmania, a recording growth meter has been constructed which detects growth of a rapidly elongating root in a few seconds. Studies during the past year have greatly clarified the understanding of cobalt deficiency of grazing sheep and clarified especially the occasional rapid precipitation of the deficiency syndrome in flocks depastured on incipiently cobalt-deficient terrain. Marked progress was also made in the study of BHC and DDT dipping fluids for control of cattle tick.

The Division of Tribophysics has shown that at least three mechanisms may operate in the liberation of stored energy in the heating of a deformed metal, and the manner in which the energy associated with these three processes varies with the deformation has been studied for nickel, arsenical copper and pure copper. Analytical and kinetic investigations with selected hydrocarbons show that gaseous oxidation at high temperatures occurs in two successive stages, the first controlled by the accumulation of active intermediates in the gas phase, and by processes at the walls of the reaction vessel, whereas in the second stage, gas phase reactions predominate. In the Division of Physics, a new method for controlling humidity, using a small ionic crystal as detecting element, has been devised, which has given promising results in the automatic measurement of dew-point temperature, in the accurate regulation of humidity in air-conditioned rooms, and as a self-balancing instrument with sensitivity equivalent to 0·01 deg. C. in dew-point, and response time of only 0·3 sec. The energies of alpha particles from certain natural radioactive substances and the gyromagnetic ratio of the proton have been redetermined, and work continued on the relation between the chemical and physical structure of pure compounds and their dielectric properties. Investigation of a proposed method for navigating long-range aircraft by distance measurement was concluded, but is not being carried further on account of the complexity of the instrumentation and the limit of 1,400 miles on the separation of the stations. Laboratory and road trials established the reliability of two radio-Doppler devices for remote measurement of the speed of road vehicles. Basic studies are being made of the physics of the atmosphere, with the object of attaining a more fundamental understanding of the weather and the processes which control it, and the Division of Radiophysics made several important studies relating to the Sun and galaxy. A detailed study of the southern part of the galaxy is in progress, which, when combined with the results from similar studies in the northern hemisphere, should afford a three-dimensional map of the spiral structure of the galaxy. A special interferometer, 1 km. wide, for use on solar disturbances is being constructed, while search has been made for evidence of radio emission from the planet Jupiter. Theoretical work centred on the origin and transmission of electromagnetic waves in an ionized gas.

CHEMICAL ENGINEERING IN THE UNITED STATES

THE Department of Scientific and Industrial Research, Overseas Technical Report No. 2 (pp. vi+24. H.M. Stationery Office. 2*s*.), on "Chemical Engineering in the U.S.A.", is one of a series of surveys on technological subjects which is being made under the ægis of the scientific attaché to the British Embassy in Washington. The present report was prepared by Dr. P. H. Calderbank, a member of the staff of the Chemical Research Laboratory, and is based on visits to educational and industrial establishments, and on meetings with representatives of those concerned with the selection, training and employment of chemical engineers in the United States. The report deals with the development of chemical engineering, the progress of which in the United States has been spectacular, the present position in chemical engineering education, and some recent trends in chemical engineering practice.

The older engineering professions have been concerned with the application of certain scientific principles to the building of structures and machines. The creation of the chemical industry required the introduction of a new range of principles, among

which the rate-process figured prominently; and from this development chemical engineering emerged. It led to a quickened interest in equilibrium conditions and in thermodynamics generally; and in the mechanisms of turbulent transfer and the processes occurring at phase boundaries.

Chemical process development in Germany occurs through co-operation between the industrial chemist and the mechanical engineer with process training (the 'process engineer'). In the United States the co-operation is between mechanical engineers and chemists who have had process training ('chemical engineers'). This difference, the report remarks, "seems to be due to the historical reasons which determined whether chemists or mechanical engineers took the initiative in embracing the principles of the physically controlled rate-process. However, the chemists' established familiarity with the chemical rate-process and the fact that the latter is frequently modified by physically controlled transfer phenomena seem to suggest that the American development was the more logical and satisfactory".

Of particular interest is the American approach to chemical engineering training. Under the 'practice school' made famous by the Massachusetts Institute of Technology, groups of students work in an industrial plant with their instructor on problems of interest to their host company. Many industrial firms are willing to take part in this scheme, which is generally considered to offer valuable training and a useful introduction to industrial life. The 'plant design' class, which is usual in Britain, has also been widely adopted in the United States. Students are required to co-operate with each other and with their supervisor in designing full-scale chemical plant. This emphasizes the element of co-ordination between various fields of study and introduces the importance of economic factors. There is also the 'co-operative scheme', similar to the British 'sandwich course', in which students divide their time between the university and industrial undertakings to which they are apprenticed.

The original division of the subject into 'unit operations' is coming to be regarded as arbitrary. It is increasingly appreciated that much of chemical engineering involves the wider application of comparatively few basic principles, which afford a greater economy and elegance of treatment than the former avenue to the subject through unit operations. The 'problem method' of instruction lays stress on the solution of large numbers of set problems: an approach enabling the student to meet a variety of different processes, not in compartments as unit operations, but as exemplars of the basic techniques. A recent development is thus an increasing emphasis on teaching simply the fundamental principles of engineering science. These courses contain no technology, but concentrate entirely on basic physics, chemistry and mathematics. Graduates are expected to fit equally well into any of the established branches of engineering. Specialization is relegated to a later stage: the student acquires his specialist training either by postgraduate research and advanced study or by practical experience as an apprentice in industry itself.

The report explicitly avoids any comparison between British and American chemical engineering practice. But some of the unique features of the American organization, both of the profession and the training required for it, invite close and profitable attention.

AUTOMATIC COMPUTERS IN CLERICAL WORK

THE first report of the inter-departmental study group representing the National Physical Laboratory, the Treasury and the Ministry of Pensions and National Insurance which is working at the National Physical Laboratory on methods of doing clerical work with fully automatic computers has now been published*. It deals with wage accounting and gives detailed information applicable to all forms of payroll work. The report covers the subject broadly, while taking the specific case of weekly wage accounting at the Central Office of the Ministry of Pensions and National Insurance at Newcastle as an example for more detailed study, and is written for a wide range of readers, from the expert in business who knows little about computers to the expert in computers who knows little about business.

The contents consist of fourteen sections and five appendixes. After an introductory section, the essential features of a fully automatic computer are outlined and some details are given of the particular serial computer DEUCE (Digital Electronic Universal Computing Engine), which is used as an example in the report. The main store in DEUCE is a magnetic drum of capacity 250,000 bits, and data and instructions are fed into the store on punched cards. Section 3 describes the task of the pay branch at Newcastle in respect of weekly wages and the methods used, together with an estimate of the cost, and Sections 4–7 a hypothetical computer system, based on the use of DEUCE, with the addition of auxiliary equipment consisting of magnetic tape-operated printing equipment, which is proposed to replace the present methods. The auxiliary equipment is not yet available, but it is considered that it could be developed within the next two years. The scheme considered employs a high-speed computer to calculate each worker's overtime and find out how much income tax he should pay and then deduct it and his National Insurance contributions from his gross wages. Many organizations arrange for voluntary contributions for sports clubs and the like. Not only will the computer deal with this, but it also remembers to give a warning a fortnight before a man's pay increment is due.

Section 8 gives an estimate of the annual cost of such a computer system and shows that it can be economic. Calculations for a staff of 3,400 paid weekly with overtime but not piecework can be done by the machine in an hour, but forty-three man-hours of labour are required to feed and extract the information. It would require a total staff of eleven, most of them on a part-time basis, against twenty-two full-time staff used at present, though, of course, as in other forms of automation, the staff retained would have to be fairly highly skilled. Further details of the type of auxiliary equipment required are given in Section 9 and various possible alternatives of design of the computer system in Section 10. Topics discussed in the remaining sections include the application of computers to other payroll work than that of the Central Office; reliability, faults and fault indication; and data sorting. The appendixes include notes on the binary scale and binary coded notation.

* National Physical Laboratory. Wage Accounting by Electronic Computer—Report No. 1 of the Inter-Departmental Study Group on the Application of Computer Technique to Clerical Work. Pp. ii+57. (London: H.M. Stationery Office, 1956.) 2s. 6d. net.

WIND STRUCTURE IN THE TRADES

IT is now forty-two years since Sir Geoffrey Taylor inaugurated modern scientific study of the dynamics of wind in the lower layers of the atmosphere with his theoretical and experimental work on turbulent viscosity published in the *Philosophical Transactions of the Royal Society* in 1915. That work was a direct consequence of the sinking of the *Titanic* and Taylor's appointment to investigate, in the *Scotia*, the meteorology of the ocean area in which the *Titanic* sank.

The latest research on the subject is that by H. Charnock, J. R. D. Francis and P. A. Sheppard in the same series (*Phil. Trans.*, A, No. 963, **249**; Oct. 1956). These workers made 466 double-theodolite pilot balloon ascents from the island of Anegada in the West Indies in the spring of 1953. This island is in the easterly trade-wind belt. The trade winds in this area are very suitable for detailed study of wind structure because of their comparative constancy and, above all, because they decrease with height above the relatively small height of 350 m. The decrease above this height is due to the fact that the air temperature at a fixed height increases from north to south, so that the north to south fall of pressure, giving easterly winds, decreases with height. Up to 1,000 ft. the wind increases with height because of increasing distance from the sea surface. This kind of variation of wind with height permits calculation of the drag exerted by the ocean on the wind. The value of the drag for these winds, of speed about 6 m./s., is 0·41 dynes/cm.^{2}, which corresponds to a drag coefficient of $1{\cdot}24 \times 10^{-3}$. There were also evaluated the variation with height of the downwind and crosswind eddy stresses, the coefficient of turbulent viscosity and the eddy-velocity products.

The downwind coefficient of turbulent viscosity came out at about 1×10^3 cm.^{2}/sec. and the crosswind one about three times as great.

The eddy velocity products, $(u')^2$, etc., showed that the turbulence was not isotropic at any height in the layer, 1,350 m. deep, through which observations were made. The downwind eddy velocity variances were of the order of 50,000 (cm./sec.)^2, the crosswind ones about 120,000 and the vertical ones 1,200 at most. This is rather a surprising result, showing that the damping effect of the sea surface on vertical eddy movements extends to a greater height than had earlier been realized.

SOME RECENT ASTRONOMY AT TOKYO

THE *Annals of the Tokyo Astronomical Observatory* (University of Tokyo. Second Series, **4**, No. 3; 1956) contain two papers, the first of which is "Tables for the Approximate Special Perturbations by Means of the Variation of Parameters", by Tadao Takenouchi. With mean anomaly for every 10 degrees from 0° to 180°, nine coefficients have been computed to three-decimal accuracy, except in the case of the eccentricity, where two-decimal accuracy is sufficient. The coefficients are as follows: $\alpha = \cos E - e$, $\beta = \sin E$, $\gamma = -\sin E/(1-e\cos E)$, $\delta = \cos E/(1-e\cos E)$, $\lambda = -2e\sin E$, $\mu = (1-e\cos E)^2$, $\nu = -1/\mu^{1/2}$.

The tables can also be adapted for the computation of ephemerides. A numerical example of their application is given.

The second paper, by Masatoshi Kitamura and Tsuyoshi Nakamura, with the title "A Photoelectric Study of the Atmospheric Extinction at Tokyo Astronomical Observatory", deals with the weakening of starlight passing through the Earth's atmosphere; this weakening is caused by absorption and scattering due to particles in the atmosphere, and the amount of extinction and its dependence on wave-length are important in the reduction of spectral photometry. Pure extinction is due to the molecules of pure air, while haze effect is caused by water vapour, dust and smoke, the amounts of these continually varying; this haze effect is conventionally known as 'dust' extinction. As the Observatory is at Mitaka, a suburb of Tokyo, local conditions require that observations should be carried out towards the west, and these were made with the photoelectric apparatus attached to the 26-in. refractor of the Observatory, from the zenith towards the western horizon. The selected stars were β And. and β Tri., spectral type M0 and A5, respectively, and the observations were carried out on December 5–6, 1955, and January 9–10, 1956. Observations were made in 1951 by T. Dambara with the same apparatus on α Gem. *A* (A0), and these were placed at the disposal of the authors. All three stars pass close to the zenith at Tokyo.

The reduction of observations was based on the well-known formula $\Delta M = k \sec Z$, where ΔM is the loss of light in magnitude, and k is the extinction coefficient. This varies with the wave-length of the light, and formulæ for corrections of this and other disturbing factors are provided for use in the compilation of the extinctions given in Tables 1*a*, 1*b*, 2*a*, 2*b*, 3 for the stars selected. The results of extinction observations, extinction coefficients and absolute humidity are shown graphically and there is a short discussion on the dust absorption k_D, the variable part of which is mostly due to the amount of water-vapour, for the lower atmosphere may be considered to absorb the starlight at discrete wave-lengths. Taking into consideration all the meteorological conditions at Tokyo, it is considered that no useful results would be obtained by discussing the atmospheric extinction there from data for zenith distances greater than 60°.

IMPACT OF INDUSTRIALIZATION ON RURAL LIFE IN THE BELGIAN CONGO

AN account of the impact of industrialization on rural life in the Belgian Congo has been given by the Rev. J. E. Young, of the Baptist Missionary Society (*Rural Life J.*, No. 10; November 1956). The developments have taken place under the guidance of the Belgian Colonial Government, and this administration has achieved a considerable degree of success, perhaps a higher degree than most of its neighbours in Africa.

Stanley's journey nearly eighty years ago revealed a vast country of enormous potential wealth. To exploit this wealth, 280 miles of railway were built from the coast, by-passing the rapids of the lower Congo. The vision and judgment of King Leopold

and a small group of pioneer enthusiasts carried this through by 1900, so setting the scene for the establishment of law and order and the development of the country.

Trade in the early days consisted of bartering for palm oil, palm nuts and rubber, all gathered in the raw state by Africans. With the railways came the establishment of plantations by companies, including those that now form the Lever Group. Copper was discovered in the south-east, bordering Northern Rhodesia, then gold in the north-east, followed by diamonds and tin, and finally uranium. Mining developed steadily until 1929 and, after a slump, began to recover when the Second World War broke out.

Before the War, the established pattern of economy was mining in the south-east and north-east, and elsewhere, where soil and climate permitted, agriculture. Now a vast change is taking place; Belgium, mindful of its own strategic position, is sending more of its citizens to the Congo, and starting every type of industry. Consequently, the population of Leopoldville, the capital, has grown in twenty years from 50,000 to 350,000 and will reach 500,000 by 1960. In other centres, too, light industry is being developed.

Light manufacturing industries are operated in smaller units than mines and cannot spend large sums on welfare schemes. They are, however, situated in large cities which cast the spell of high wages over the African, but living conditions are nowhere near as good as in mining 'camps'. Recently, the Government has, by direct action, and by pressure on employers, launched building work in all the big cities. Africans, assisted by a Government-sponsored 'building society', can and do buy their own houses. Social services have been greatly expanded, but the population has grown too fast for them. There is an acute shortage of teachers.

New factories and houses go up constantly, creating a demand for man-power that drains the countryside of its young men. The territory of Kasangulu has been so depopulated that the Government colonized it with other Africans and granted them credit to start market gardening. The magnetic draw of the capital is felt two hundred miles away, some villages having only old men, women and children left.

The impact of industrialization has done great harm to rural communities; but the Government is alive to the situation, and is eager to maintain the rural population. Employers also realize that productivity depends upon a healthy, contented and stable labour force. Plantation companies followed the lead of the mining companies in improving conditions, which resulted in a stabilization of the workers' families and a change in the shape of the rural community. Around existing plantations were created zones of influence where villagers made palm plantations on their own land. The scheme operated under a tripartite contract: villagers provided land and labour; the company provided seed, transport and a market; the Government supervised, advised, maintained roads and arbitrated between villagers and the company.

The Government is faced with the problem that the economic development of the Belgian Congo demands that urban populations grow, and grow rapidly; but they must also be fed by a stable and contented rural population. The Congo imports food from neighbouring Colonies and from overseas. To solve this problem the Government has created peasant settlements (*paysannats indigènes*). These smallholding communities are organized to make the best use of land and to increase both productivity and soil fertility, and each settlement is large enough to provide worth-while social services.

The first of these settlements was at Torumbu, seventy miles from Stanleyville. Since 1942 long strips of land running east and west have been cleared and planted each year; these cultivated strips are separated by forest strips of equal widths of about a hundred yards. The chief allocated each peasant a portion of each strip as it was brought into cultivation. This he farmed for three years and the produce belonged to him absolutely; after three years the land went back to the chief and was rested for fifteen years. Peasants each had an additional plot of one acre near their houses and other plots in a perennial plantation of oil palm and coffee. The homestead plots were in groups of about thirty and formed hamlets, a number of which were sited around the community centre. The crops grown and sold were maize, bananas, rice, cassava, peanuts and soya. A co-operative was formed to organize marketing, and later acquired farm machinery. The success of the venture is now assured; in 1953, two thousand cultivators were living on the settlement and the drift to the towns had ceased.

The Belgian Government is pressing forward with the extension of this valuable system. By 1958 it is hoped that half a million peasants will be suited; with their families they will form one-sixth of the country's population.

EFFECT OF HEXŒSTROL ON CARCASS COMPOSITION AND EFFICIENCY OF FOOD UTILIZATION IN FATTENING LAMBS

By T. R. PRESTON and ISOLINE GEE
Rowett Research Institute, Bucksburn, Aberdeenshire

SYNTHETIC œstrogens have been shown to induce greater and more economical live-weight gains in lambs[1–7]. To some extent these advantages have been offset by consistent reports of a reduction in carcass quality[2–8]. Where detailed carcass studies have been made[4], it was found that the subcutaneous fat was thinner and contained more moisture, but that there was little change in muscle measurements or intermuscular fat. It was suggested[8] that the increase in live-weight and subsequent carcass weight of treated lambs might be entirely due to an increase in moisture content of the tissues and a greater percentage of offal. These conclusions have been based on limited analyses of small sample joints, such as the 11–12–13 rib cut. Since œstrogens alter the conformation of the animal[10] and may affect parts

of the carcass differently, the composition of such sample joints may not be representative of the carcass as a whole. Moreover, the claims that œstrogen treatment improves efficiency of feed conversion are based on live-weight measurements only and can have little significance until the composition of the extra live-weight of treated animals is known.

The main purpose of the following experiment was to determine (*a*) the chemical composition of the increases in carcass weight of œstrogen-treated lambs, and (*b*) the relative efficiency with which treated and untreated lambs convert the protein and energy in the feed to protein and energy of the edible carcass.

Thirty-six Suffolk × Half-bred five-month old wether lambs were allocated at random to three groups. One group, designated the sample slaughter group, was killed at the beginning of the experiment. The carcasses were split down the back, and the left side of each carcass jointed into leg, loin and 'rest' (that is, forequarter, tail, pelvis, ribs and flanks). The joints were separated into subcutaneous fat, bone and remaining flesh. The flesh and subcutaneous fat were analysed chemically for fat and moisture; protein was calculated as 90 per cent of the dry fat-free tissue[11].

A 15-mgm. hexœstrol pellet was implanted subcutaneously in an ear of each of the members of the second group; the third group served as a control. The lambs of both these groups were housed individually indoors and were fed 100 gm. hay daily and increasing amounts of a concentrate mixture (56 per cent maize meal, 14 per cent crushed oats, 14 per cent bran, 8 per cent linseed cake meal, 8 per cent fish meal) for a period of approximately ninety days. After fifty days it was no longer possible to feel any of the pellet in the ears of the implanted animals and re-implantation with a further 15-mgm. pellet of hexœstrol was carried out.

Table 1. Weight Gains and Carcass Data for Control and Hexœstrol-Implanted Lambs

	Control group	Hexœstrol group
Initial live-weight (lb.)	85	83
Live-weight at slaughter (lb.)	126	135*
Live-weight gain (lb.)	41	52†
Length of fattening period (days)	91	96
Carcass-weight (lb.)	65·2	68·8
Killing out percentage $\frac{\text{cold carcass weight} \times 100}{\text{live-weight at slaughter}}$	51·8	51·0
Weight of leg joint (lb.)	6·86	7·28‡
Weight of loin joint (lb.)	5·64	5·25
Weight of rest of carcass (lb.)	20·30	21·90‡

* Significant at $P < 0.01$
† " " $P < 0.001$
‡ " " $P < 0.05$

The animals were slaughtered at comparable stages of fatness as decided by two independent judges. The same procedure of jointing, dissection and analysis was followed as described for the sample slaughter group. In addition, several external and internal measurements were made on the carcasses.

Live-weight and carcass data set out in Table 1 show that lambs implanted with hexœstrol made significantly greater daily live-weight gains, and at the end of the fattening period had heavier carcasses than the controls. There was no significant difference in killing out percentage between the two groups, or in the time taken to reach the same degree of finish. The effect of hexœstrol on the weights of the different joints is interesting, for the leg and 'rest' joints were significantly heavier and the loin lighter in treated lambs.

Table 2. Increases in Bone and Edible Tissues (in kgm.) of Control and Hexœstrol-Implanted Lambs

	Control group	Hexœstrol group
Increase in carcass	9·86	12·18*
Increase in edible meat	9·40	11·12†
Increase in fat in edible meat	5·16	4·86
Increase in protein in edible meat	0·95	1·32*
Increase in moisture in edible meat	3·20	4·82*
Increase in bone	0·46	1·06‡

* Significant at $P < 0.01$
† " " $P < 0.05$
‡ " " $P < 0.001$

The carcass composition of the lambs in the treated and control groups at the beginning of the experiment were predicted from their live-weights using equations calculated from the live-weight and carcass composition data of the sample slaughter group. (The equations were of the form $Y = bX + C$, where Y is an appropriate measurement, for example, weight of fat in carcass, weight of protein in carcass, etc., and X is live-weight of animal.) Since carcasses of both groups were analysed at the end of the experiment, it was possible to calculate the increases in the various components of the carcasses over the treatment period as shown in Table 2.

The increases in carcass-weight, edible meat and bone were significantly greater in the treated as compared with untreated lambs. There were significantly greater increases in protein and moisture in the edible meat of hexœstrol-treated lambs; on the other hand, the increase in fat was greater in the controls. These differences between carcasses from treated and untreated animals were supported by the carcass measurements. Treated lambs had a thinner fat cover (panniculus adiposus) over the carcass as a whole and appeared to have a better muscle development. From the average consumer's point of view, both these characteristics would be viewed with favour.

There is unanimous agreement that lambs implanted with synthetic œstrogens require less food per unit of live-weight gain than untreated lambs[2,4,7]. In this experiment the hexœstrol-implanted lambs made greater increases in live-weight, carcass-weight and edible meat per unit of organic matter consumed than the controls (Table 3). The most interesting feature of the results is the effect of hexœstrol on

Table 3. Feed Conversion Efficiencies in Hexœstrol-Implanted and Control Lambs

	Control group	Hexœstrol group
Increase in live-weight/organic matter consumed (kgm./kgm.)	0·191	0·236*
Increase in carcass weight/organic matter consumed (kgm./kgm.)	0·105	0·122†
Increase in edible meat/organic matter consumed (kgm./kgm.)	0·998	1·116
Increase in energy in edible meat/organic matter consumed (kcal./kgm.)	0·580	0·539
Increase in protein in edible meat/protein consumed (kgm./kgm.)	0·058	0·076†

* Significant at $P < 0.01$
† " " $P < 0.05$

the animals' capacity to convert food protein to meat protein. Treated lambs were found to be 31 per cent more efficient in this respect and thus substantiate the reports of Whitehair *et al.*[12] and Jordan[13], who found that nitrogen retention was increased by œstrogen treatment. On the other hand, energetic efficiency (that is, the conversion of food to edible matter in terms of calories) was slightly less in the treated animals.

The mode of action of synthetic œstrogens is imperfectly understood. Clegg and Cole[14], on the basis of their finding that there was no difference in bone or percentage moisture between treated and untreated steers, suggested that the increased weight gains following treatment were due to an increased protein anabolism. They postulated that œstrogens stimulate the anterior lobe of the pituitary body to secrete adrenocorticotropic hormone which in turn stimulates the adrenal cortex to produce androgens possessing protein anabolic activity. This thesis is not entirely supported by the results of our experiment. That there should be increases in bone and moisture as well as in protein, and that carcass extremities, for example leg, should be developed more than late-maturing parts such as the loin, suggest that hexœstrol promotes somatic growth and not merely protein anabolism. Clegg and Cole's data have also been interpreted to mean that œstrogens cause an increase in output of growth hormone from the pituitary body[15]. This explanation might seem more plausible in view of the findings of the present experiment.

A more detailed report of this work will be published elsewhere. Grateful acknowledgment is accorded to Mr. W. A. Boyne for carrying out the statistical analyses.

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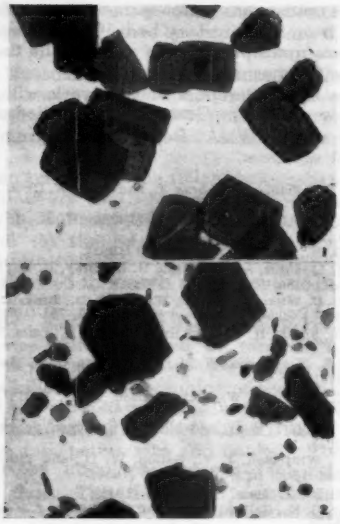
CRYSTALLINE CYTOCHROME *C*

Crystallization of Cytochrome *c* from Fish

THE main procedures of preparation and various properties of crystalline cytochrome *c* from baker's yeast, beef and pig heart muscle have recently been reported[1]. From these sources cytochrome *c* crystallized as needles which were sometimes grouped into rosettes or leaflets; that from horse heart and skeletal muscle, obtained by the same method, crystallized as needles, although they were very small and have not yet been obtained as large crystals[2]. Quite differently shaped crystals, very large and plate-like, were obtained recently from the heart muscle of fish—bonito (*Katsuwonus vagans*, Lesson) and also tunny (*Thynnus alalunga*, Gmelin). The method of preparation was the same for both.

The connective tissue was removed from the frozen hearts, which were rapidly washed and minced. The cold mince was suspended without delay in the same volume of 0·85 saturated ammonium sulphate solution containing 0·06 *N* ammonium hydroxide, and the suspension homogenized in a Waring blendor. After standing at room temperature (about 20° C.) for 2 hr., the suspension was filtered with 'Celite' and the residue washed with neutralized 0·55 saturated ammonium sulphate solution. To the mixture of the filtrate and washings (about 0·55 saturated ammonium sulphate, *p*H 7·2–7·6), solid ammonium sulphate was added until the specific gravity was 1·230 (about 0·8 saturation). The resulting precipitate was removed and cytochrome *c* was precipitated from the filtrate by adjusting the *p*H to 4·5 with 3 *N* trichloroacetic acid in the cold. After removing the ammonium sulphate solution by filtration and compression between filter papers, the precipitate was dissolved in a large volume of distilled water so that the concentration of the ammonium ion came below 0·05 *M*. The cytochrome *c* in the solution was adsorbed on a column of the resin, 'Duolite *CS*-101' (or 'Amberlite *XE*-64'), then eluted with neutralized 0·1 saturated ammonium sulphate solution (see ref. 1). The purified and concentrated cytochrome *c* solution was nearly saturated with ammonium sulphate, brought to about *p*H 9·5 with ammonia, kept at 2–5° C. overnight and then filtered in the cold. After dialysing the filtrate, cytochrome *c* was adsorbed on the minimum amount of 'Amberlite *XE*-64'. This resin with adsorbed cytochrome *c* was placed on a column of 'Amberlite *XE*-64' treated with sodium hypochlorite and ammonium phosphate buffer (*p*H 7·0, 0·25 ammonium ion) and then chromatographed with the same buffer (see ref. 1). From the widest band which contained the largest amount of cytochrome *c*, the protein was concentrated by the adsorption and elution technique (see ref. 1), using a small column of the resin.

The solution containing 5 per cent cytochrome *c* was brought to about 0·8 saturation with ammonium sulphate and to *p*H 8·0–8·5 with ammonia to which ascorbic acid had been added to reduce cytochrome *c* completely. After removing a slight precipitate by centrifugation, the supernatant solution was cooled in ice-water and then brought to slight turbidity by the addition of finely powdered ammonium sulphate. When the solution was allowed to reach room tem-



(1) Crystalline cytochrome *c* of *Katsuwonus vagans*, Lesson.
(2) Crystalline cytochrome *c* of *Thynnus alalunga*, Gmelin (× 150)

perature, small and badly formed crystals appeared, together with an amorphous precipitate. In order to dissolve the amorphous precipitate and obtain large and better-shaped crystals, the suspension was cooled again and allowed to reach room temperature while being mechanically stirred. Stirring was continued for 3 hr., during which time a small amount of ammonium sulphate was added in two lots to give an increase of about 0·01 in saturation; then the suspension was allowed to stand at room temperature for one to two days. Recrystallization was carried out in the same way. The yield of the crystalline cytochrome *c* was higher than from other sources[1,2], amounting to 60 mgm. from 1 kgm. of heart muscle of each fish (Figs. 1 and 2).

This method was somewhat different from that already reported (see ref. 1) for mammalian cytochrome *c*; but it gave better results than that used with horse and beef heart muscle since modification of cytochrome *c* was prevented. This modification occurred in the course of preparation, especially during extraction and treatment with trichloroacetic acid, and resulted in several fractions of cytochrome *c* on the column of ion exchange resin[3].

The crystals were large and so strongly coloured (reddish orange) that the absorption bands of single crystals at 550 mμ and 520 mμ were visible with a microspectroscope. The adsorption spectrum of the crystalline cytochrome *c* from bonito was the same as that from tunny at all wave-lengths and the same as that from beef and pig heart muscle in the visible range both in oxidized and reduced form. However, the relative extinction of oxidized fish cytochrome *c* against that at 550 mμ in reduced form was considerably higher at 280 mμ and slightly lower around 300 mμ than that of beef heart muscle. The ratio of the extinction of reduced fish cytochrome *c* at 550 mμ to that of the oxidized form at 280 mμ showed a rather low value, 1·04 ± 0·02. This corresponds to the value 1·00 which was obtained by Paléus in a pure salmon preparation the iron content of which was similar to that of the purest beef preparation[3].

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Bunji Hagihara Ichiro Morikawa
Kunio Tagawa Jinpei Yamashita
Mitsuhiro Nozaki Kazuo Okunuki

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N-Terminal Residues of Crystalline Cytochrome c from Yeast and from Heart Muscle of Horse and Beef

Tuppy *et al.*[1] have published a series of papers on the determination of the amino-acid sequence in the proteolytic digestion products containing the hæm moiety from cytochrome c. Margoliash[2] has recently reported that cytochrome *c* purified, but not crystallized, from horse heart muscle has two histidines as the N-terminal residues using the fluorodinitrobenzene method[3].

Recently, cytochrome *c* has been crystallized from several sources[4] and extensively investigated in our laboratory. The results obtained by us were not in agreement with those of Margoliash[2]; arginine and threonine were detected as the N-terminal residues in the case of yeast cytochrome *c*, whereas only arginine was determined in the case of horse and beef heart muscle. Although it is not unreasonable to expect that histidine may be detectable when the phenylisothiocyanate method is used, it was never detected by the fluorodinitrobenzene method. Determinations of the N-terminal residues of crystalline cytochrome *c* are reported here.

(I) Yeast Cytochrome *c*

(*a*) Cytochrome *c* was crystallized from the eluate of all bands (cytochrome *c* shows the presence of more than one component under certain conditions[5]) on an ion-exchange resin column by the method of Hagihara *et al.* (see ref. 4). It was dialysed against dilute sodium chloride solution, then sodium bicarbonate, fluorodinitrobenzene and ethanol were added to the solution according to the method of Sanger[3]. After shaking the mixture for 3 hr., the precipitate of dinitrophenyl cytochrome *c* was washed and hydrolysed with 5·7 *N* hydrochloric acid for 8 hr. at 105° C. The hydrolysate was extracted with ether and the extract was identified by paper[6] and silica gel[7] chromatography, and the aqueous layer by ion exchange resin[7] and paper chromatography[8]. Dinitrophenyl-threonine and α-mono-dinitrophenyl-arginine were identified.

(*b*) When cytochrome *c* crystallized from fraction 8 on the column was treated as above, dinitrophenyl-threonine and α-mono-dinitrophenyl-arginine were estimated as less than 1 mole per molecule of cytochrome *c*, assuming a molecular weight of 13,000.

(*c*) Crystalline cytochrome *c* from fraction 4 was treated as before except that it was hydrolysed for 16 hr. The same result was obtained.

These findings suggest that cytochrome *c* from yeast has two N-terminal residues, and each preparation crystallized from the separated fraction on an ion-exchange resin column has the same N-terminal residues.

(2) Cytochrome *c* from Horse Heart Muscle

(*a*) The solution of cytochrome *c* to be crystallized was used. Bicarbonate, fluorodinitrobenzene and ethanol were added to the solution and stirred for 4 hr. at *p*H 9·0. Dinitrophenyl-protein was separated and hydrolysed for 16 hr. The ether extract contained a small amount of some dinitrophenyl-amino-acids and the aqueous layer contained α-mono-dinitrophenyl-arginine; but *bis*-dinitrophenyl-histidine and α-mono-dinitrophenyl-histidine were not detected.

(*b*) Crystalline cytochrome *c* prepared by the method of Hagihara *et al.* (see ref. 4) was dinitrophenylated for 3 hr. by shaking with sodium carbonate, sodium bicarbonate (*p*H 9·0) and acetone (it has been shown that histidine is dinitrophenylated under these conditions). Dinitrophenyl-cytochrome *c* was hydrolysed with acid for 6 hr. at 105° C. and α-mono-dinitrophenyl-arginine was estimated as less than 1 mole. *Bis*-dinitrophenyl-histidine and α-mono-dinitrophenyl-histidine were not detected. The aqueous layer was hydrolysed for another 16 hr. and the same result was obtained.

(*c*) Cytochrome *c* prepared by the method of Keilin and Hartree[9] was treated as in (*b*). Some dinitrophenyl-amino-acids were identified in small amounts and α-mono-dinitrophenyl-arginine was estimated as less than 1 mole.

These results show that cytochrome *c* from horse heart muscle has one N-terminal residue.

(3) Cytochrome *c* from Beef Heart Muscle

Crystalline cytochrome *c* prepared by the method of Hagihara *et al.* (see ref. 4) was treated as in 2 (*b*), except that it was hydrolysed for 22 hr. The ether extract contained scarcely any dinitrophenyl-amino-acid, but the aqueous layer contained less than 1 mole α-mono-dinitrophenyl-arginine. This suggests that cytochrome *c* from beef has one N-terminal residue.

The identifications of α-mono-dinitrophenyl-histidine and α-mono-dinitrophenyl-arginine were examined using the Pauly[10] and Sakaguchi[11] reactions, respectively, for cytochrome *c* from horse and beef heart muscle. The Sakaguchi reaction was positive for the α-mono-dinitrophenyl-arginine on the paper chromatogram, whereas the identification of α-mono-dinitrophenyl-histidine by the Pauly reaction was unsuccessful.

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HIROSHI MATSUBARA
BUNJI HAGIHARA
TAKEKAZU HORIO
KAZUO OKUNUKI

Department of Biology,
Faculty of Science,
University of Osaka,
Osaka, Japan.

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INITIATION OF DETONATION BY PROJECTILE IMPACT

By DR. K. E. SPELLS*

Armament Research Establishment, Ministry of Supply

AND

DR. D. W. WOODHEAD

Safety in Mines Research Establishment (Ministry of Fuel and Power), Buxton

INITIATION of detonation in solid explosives by projectile impact has been the subject of wide study, but photographs showing the phenomenon in detail do not appear to have been published and there has been speculation as to the precise sequence of events.

This communication describes experiments in which the Buxton rotating-mirror camera (as adapted to schlieren photography) was used for photographing the impact of a mild steel fragment when projected with high velocity against the plane end of a cylindrical high-explosive pellet (the target charge) of diameter 1·25 in. and 3·8 in. long. The method of projection used was developed before the Second World War by the Research Department, Royal Arsenal, Woolwich, and consisted first in setting the fragment (a cylinder of diameter 0·214 in. and 0·125 in. long) centrally in a Woods metal surround so that the whole formed a circular disk, 1·25 in. in diameter, with the plane faces of the fragment coplanar with those of the disk of which it formed part. The disk was then placed concentrically against the end of a cylindrical pellet of pressed tetryl (the projector charge) of 1·5 gm./cm.³ density and of the same dimensions as the target charge; this assembly, which now formed a continuous

* Present address: R.A.F. Institute of Aviation Medicine, Farnborough, Hants.

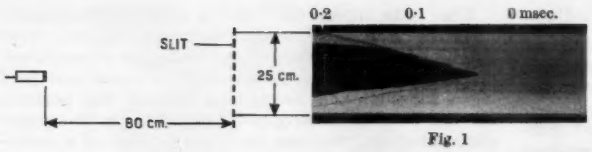


Fig. 1

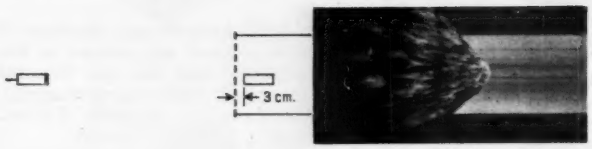


Fig. 3

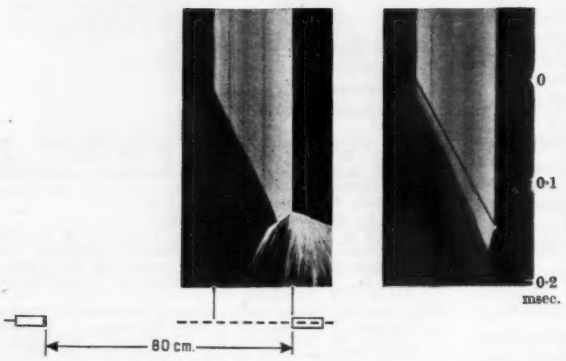


Fig. 2 Fig. 4

Rotating-mirror schlieren camera records with a slit perpendicular (Figs. 1, 3) and parallel (Figs. 2, 4) to the trajectory of a high-speed steel fragment

cylinder, was held together by transparent tape. When a detonator, synchronized with the camera, was set off at the other end of the assembly, the fragment was projected axially. The Wood's metal surround, which was completely disintegrated by the detonation of the projector charge, prevented the break-up of the mild steel fragment.

Projector and target were suspended coaxially with an air-gap between them. For good definition the field of view of the camera was restricted by a slit, of effective width in the object plane of 2 mm., and in most experiments axial records were taken, that is, the common axis of the projector and target was arranged to lie within the field of view. Trial photographs taken without a target and with the projector axis perpendicular to the camera slit showed that the fragment began to emerge from the accompanying cloud of Wood's metal after travelling about 60 cm. and was well clear after 80 cm. Fig. 1 is an example of these photographs. As in the rest of the illustrations, the field of view, in this case a plane 80 cm. in front of the projector, is represented by the broken line in the diagram. First occurs the passage of the fragment, recorded as a small black rectangle, and then, after a clear interval of 0·05 msec., the arrival of the foremost part of the opaque cloud of Wood's metal. A gap of not less than 80 cm. was therefore used between the projector and target charges. The accuracy of projection was such that a complete 'miss' never occurred in a series of twelve experiments, although for axial records the fragment was not always directly in view. The schlieren shadow cast by the bow wave of the fragment ensured that its passage through the air gap would be recorded, however. A camera writing speed of 313 m./sec. was used throughout.

Fig. 2 is an axial record with a field of view covering the target and the last 25 cm. of an 80-cm. gap between projector and target, and shows the initiation of detonation in pressed tetryl, density 1·5 gm./cm.^{3}. The black shadow with a well-defined boundary sloping steeply towards the target was produced by the projected Wood's metal, which completely obscured the schlieren illumination. Above this boundary, sloping rather less steeply in the same direction, is a straight line produced by the bow wave of the fragment. From the slope of this line and the time-scale, the velocity of the fragment is deduced as 1,750 m./sec. A detonation wave of velocity 7,200 m./sec. (characteristic for tetryl in the form used) is seen to be initiated in the target by the impact of the fragment; also, there is a flame of velocity 4,420 m./sec. spurting backwards from the point of impact. Any delay between the arrival of the fragment and initiation of the target is evidently too short to be resolved by the present method and cannot exceed a time of order 1 μsec.

It is also of interest to investigate the sequence of events occurring in a plane perpendicular to the trajectory of the fragment at a position just in front of the tetryl target pellet. For Fig. 3, therefore, as in Fig. 1, the projector axis was perpendicular to the camera slit, which viewed the plane 3 cm. in front of the target. The gap was widened to 83 cm. The passage of the fragment is again clearly visible, and then, after an interval of 0·027 msec., an intense flame of increasing width which may be identified with the backward spurt of flame from the initiated target noted in Fig. 2. This interval must have been the total time taken by the fragment to travel the remaining 3 cm. to the target and for the flame to travel back the same distance. The two parallel lines across the centre of the record are shadows cast by suspension strings connecting the projector and target, and they define the width of the charges. The asymmetry of the fragment with respect to the lines shows the error of projection after 80 cm., and a corresponding asymmetry of the returning flame is further evidence that initiation of the target occurred at the point of impact.

A photograph (not reproduced) of the impact with a pellet of cast tetryl/TNT 40/60, density 1·62 gm./cm.^{3}, was obtained with the same geometrical arrangement of charges and viewing slit as for Fig. 2. Detonation was not initiated in this less sensitive explosive, but there was some evidence of a very weak flame at the point of impact. Material was also projected backwards from the target, and this was thought at first to be additional evidence that some combustion had occurred. However, a similar throwback of material was obtained when a pellet of concrete of the same size as the explosive targets and of density 1·75 gm./cm.^{3} was substituted for the tetryl/TNT (see Fig. 4). It happened that the fragment trajectory lay wholly within the field of view

in Fig. 4, and a small bright flash generated at the point of impact with the concrete is clearly visible.

The scale of these experiments was limited by the need to avoid damage to the schlieren camera. Therefore, conditions for the initiation of less sensitive explosives, for example, by the use of faster and larger fragments, could not be reproduced. That initiation of the target charge could have been due to heat acquired by the fragment from the projector charge does not appear possible on any reasonable assumption regarding rates of heat transfer. Support for this view is provided by the results of metallurgical tests by Mr. R. Jeffrey on fragments projected into sawdust; these showed that any appreciable heating was confined to a thin layer of little more than molecular thickness on the rear surface. Rather, it is thought that initiation is the result of the considerable local transformation of energy which must occur during the initial impact of the fragment on the target surface.

Acknowledgment is made to the Controller of H.M. Stationery Office for permission to publish the photographs.

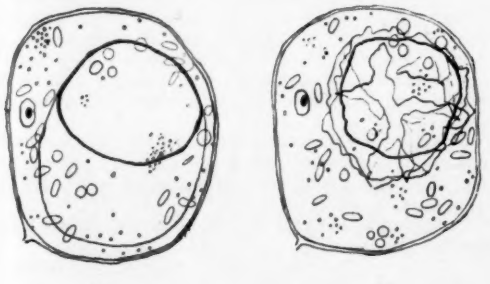
VACUOLES AND MOVEMENT IN THE PULVINUS OF *MIMOSA PUDICA*

The Contractile Vacuoles

RECENTLY, attention has been directed to the structure of the motile cell which is the unit of contractility in the pulvinus of the sensitive plant, *Mimosa pudica* Linn. As the descriptions given by Weintraub[1] and Toriyama[2] are not comprehensive and some of the observations of the two authors may seem at variance, the picture which emerges from the present extended studies is hereby given with the view of clearing up some of the ambiguity.

Watching the actual process of contraction in *Mimosa* pulvinules, Weintraub was led to believe that small transitionary vacuoles, which arise and disappear, constitute the contractile element of the cell. Toriyama makes no direct observations on contractility, but lays stress on the extensible property of the tannin vacuole, and mentions in passing that the larger central vacuole also contracts.

The structure and organization of the *Mimosa* pulvinus have been described in my previous work[3]. The structure of the cell which goes to make up the motile tissue is as follows. The cell is isodiametric with numerous plasmodesmatic connexions to neighbouring cells[3]. There is a layer of cytoplasm enclosing a large vacuole[3]. The cytoplasm supports a large nucleus, innumerable protein droplets, mitochondria and some modified chloroplasts (Fig. 1*A*).



(*A*) (*B*)

Fig. 1. Free-hand diagrams of brilliant cresyl blue stained cells of *Mimosa pudica* pulvinus. *A*, a motor cell showing cytoplasm with inclusions and the vacuole. The tannin body, drawn with a dark line, is included in the larger sac of the vacuole; *B*, the same cell treated with 25 per cent glycerine. The vacuolar membrane crumples about the tannin mass, which remains relatively inert. The cytoplasm does not plasmolyse. In intact tissue, the entire cell wall will contract along with the cytoplasm and the vacuole. (× c. 1,140)

Guilliermond[4], discussing the work of Mangenot, states that in the *Mimosa* pulvinus, tannin and non-tannin vacuoles lie side by side in the cytoplasm. Weintraub mentions that tannin vacuoles, wherever present, are in aggregates. Toriyama is of the opinion that there are two vacuoles, and the smaller tannin vacuole lies within the larger central vacuole.

The tannin mass is easily visible and reacts strongly to safranin, osmic acid and Molisch's reagent for phloroglucotannoid compounds, as discovered earlier by Molisch[5] and Bose[6]. The outer vacuole had not then been discovered, and the tannin element was taken to comprise the entire vacuole of the cell.

The large vacuole is invisible with ordinary techniques such as those mentioned above, and with the vital dyes neutral red, toluidine blue, methyl blue and methylene blue, which, however, stain the tannin mass. When janus green *B* is used for staining mitochondria, the tannin body later takes up the stain. The outer vacuole is not rendered visible by fixatives. It responds only to the vital dye brilliant cresyl blue. The dye takes 20–30 min. to react and colours only freshly hand-sectioned material. When differentiation is complete, the tannin mass, stained an iridescent indigo blue, is observed to lie to the inner side of the larger violet-coloured sac. In all cases of motility, of not only *Mimosa* but many other pulvini[7], the blue body was observed to lie included within the violet sac. In non-motile tissue adjoining the pulvinus, such as of petiole and stem, the blue and violet sacs were seen to lie side by side as observed by Mangenot. The tannin was in every case present as one single mass, but broke up into a cluster of small masses with most reagents and fixatives. In the presence of neutral red, small non-tannin vacuoles were observed to arise, comparable to the transitory neutral red vacuoles reported in *Amoeba* by Goldacre and Lorch[8].

Attempts were made to induce the large violet sac to contract, and see if it would collapse around the blue one. When sap expressed from cut pulvini was added, the outlines remained the same and the violet colour deepened in shade. The tannin mass dissolved in the agents ether, chloroform and acetone. The vacuoles crumpled up and fragmented in absolute alcohol and 10 per cent glycerine. A 25 per cent solution of glycerine was perhaps isotonic with the tannin mass as, upon treatment, the tannin mass remained as before, while the vacuolar membrane crumpled to a small mass around it (Fig. 1*B*). After

a while, the membrane partially extended out in the glycerine, and if water or pulvinar sap was added, this hastened the recovery process. It is thus clear that the membrane is contractile, while the tannin inclusion is comparatively inert.

Now it has been observed that the tannin complex may be included either as a dense mass or lightly dispersed inside the vacuole. It is entirely dissolved away in the fresh state by tannin solvents, and the organization described holds only during daylight. With the onset of darkness the discrete mass breaks up in the vacuole, and Toriyama[8] has observed tannin to issue out into the intercellular spaces at night. The quantity and density of tannin are very much less in other less motile plants[7]. All these facts lead to the conclusion that the tannin matter does not constitute a vacuole, but is merely an inclusion in the larger vacuole, which is the contractile element of the cell. Therefore, the concept of one vacuole within another is not supported by the present observations.

It has been noted that expanded vacuoles remained expanded in the presence of salts expressed from cut pulvini, but that contracted vacuoles expanded by intake of these salts. Microscopical and field observations indicate that contraction of cell and tissue is brought about by loss of these salts and recovery is brought about by imbibition of the salt-rich sap by the vacuoles (which can take in water only in the presence of these salts). Toriyama[10] has demonstrated that this sap is rich in potassium.

The help and encouragement extended by Dr. D. M. Bose, director, Bose Institute, is thankfully acknowledged.

Mridula Datta

Bose Institute, Calcutta 9.

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Vacuoles of the Pulvinus and the Mechanism of Movement

The mechanism of bending movement in *Mimosa pudica* L. is governed by the vacuolar system which is present in the cells of the motor tissue of pulvini and pulvinules. Most authors[1-3] report on the contractile nature of the tannin vacuole; but I have discovered another type of small contractile vacuole in the parenchymatous cells of the motor tissue of the main pulvinus (Fig. 1*A*, *d*). These do not contain tannin.

Many smaller vacuoles were observed by Weintraub[4] in the motor tissue cells of the pulvinule, but I differ from him in finding a lesser number of these and their size was also found to be smaller than was formerly reported by Weintraub. Unlike Aimi's[1] observation, a thin cytoplasmic layer was found at the periphery of the motor-tissue cells of the main pulvinus; this supports the opinion of Toriyama[2].

Simply on the basis of precipitation, Toriyama's[2] separation of *A* and *B* types, etc., tannin vacuoles in the main pulvinus was undesirable, because the

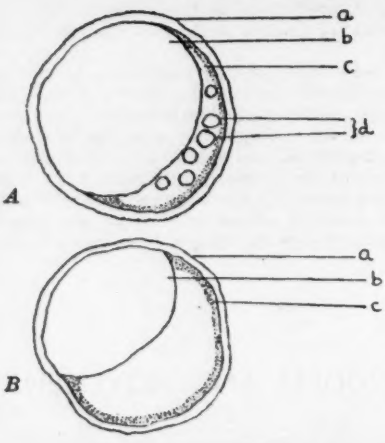

Fig. 1. Camera lucida drawings of a parenchymatous motor-tissue cell of the main pulvinus
A, before stimulus; *B*, after stimulus
a, cell wall; *b*, tannin vacuole; *c*, cytoplasmic layer; *d*, smaller vacuoles

contents were not examined by him critically. Moreover, the functions of these different types of tannin vacuoles and their relationship with the mechanism of movement were also not observed by him.

In turgid condition each parenchymatous cell of the motor tissue was found filled with a large contractile tannin vacuole and many smaller vacuoles (Fig. 1*A*). On stimulation these smaller vacuoles disappear completely and the tannin vacuole becomes smaller in size (Fig. 1*B*) and at the same time a liquid containing potassium salts was found to be present in the intercellular space. A slight contraction of the cell wall was also noticed. On recovery, however, these smaller vacuoles re-appear and the tannin vacuole becomes the same size as before, but no liquid was found in the intercellular space. So it can be concluded that this liquid was expelled out of these cells from these vacuoles, and on recovery this liquid was re-absorbed into the vacuoles, and so the loss of turgidity in these cells is due to a loss of a liquid containing potassium salts from these contractile vacuoles. By employing a modified technique of Weintraub's[1], I was able to observe the active contraction of these vacuoles under the microscope. Toriyama's[3] central vacuole was also observed on contraction of the tannin vacuole on stimulation but not in the turgid condition, which shows that there is a close relationship between these two types of vacuoles.

The presence of tannin solution in the 'canaliculated' intercellular space of Toriyama[2] was not observed by me. Hydathodes in the epidermis of the pulvinus were also observed.

Thanks are due to Prof. Shri Ranjan for his kind help and suggestions and to all my colleagues.

A. K. Dutt

Department of Botany,
University of Allahabad.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Pressure Changes during the Respiratory Movements of Teleostean Fishes

THE nature of the changes of hydrostatic pressure produced in the buccal and opercular cavities by the breathing movements of teleost fishes has been discussed by several workers[1-3]. Pressure measurements were made by Woskoboinikoff and Balabai[4], but their results give no indication of the time-course of these changes. Using a capacitance manometer, we have been able to measure pressure changes in both buccal and opercular cavities throughout the complete respiratory cycle in three species of freshwater fish. Ciné films taken simultaneously made it possible to plot the movements of the mouth and operculum without loading these structures in any way. The action of the mouth and opercular valves was also studied from the films.

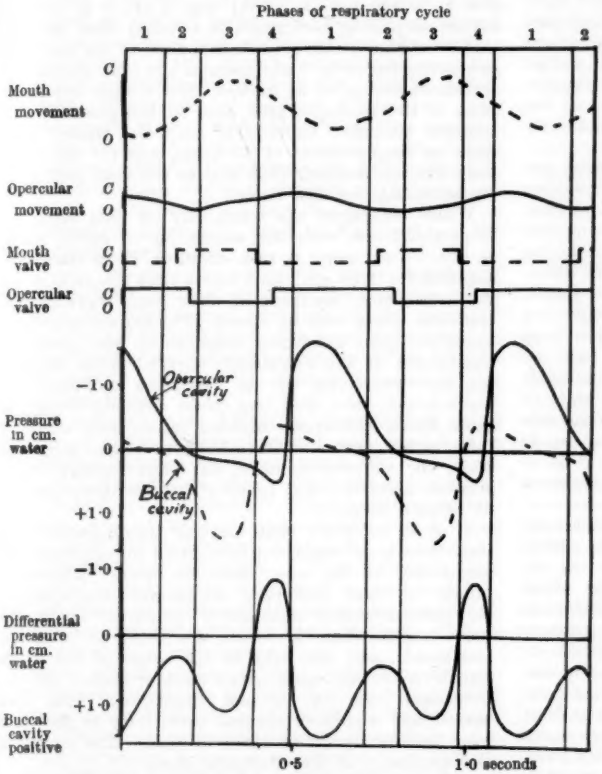

Fig. 1. Movements of the mouth and operculum with associated pressure changes in the buccal and opercular cavities during breathing in a trout (70 gm.) at 17° C. Dashed lines relate to the mouth and buccal cavity. The differential pressure between the two cavities is shown below. *C* and *O* indicate 'closed' and 'open' respectively

The events during a typical respiratory cycle of the trout (*Salmo trutta* sp.) are shown in Fig. 1. The buccal cavity begins to expand about a quarter of a cycle before abduction of the operculum starts, and begins to contract about one-fifth of a cycle before abduction of the operculum. During a single respiratory cycle, the pressure in both cavities is first negative and then positive with respect to the surrounding water, but the relative amplitude of these two parts of the pressure curves is different in the two cavities. In the buccal cavity the positive pressure, associated with mouth closing (phases 2 and 3 of Fig. 1), is the most marked; whereas the negative pressure is greater in the opercular cavity (phases 1 and 2). During these three phases water will pass across the gills as the pressure in the buccal cavity exceeds that in the opercular cavity. In phase 3 water is forced through the gills by a buccal pump; in phase 1 it is drawn through by the action of an opercular suction pump; and phase 2 is a transition during which both pumps are operating to some extent. However, between phases 3 and 1 we have invariably observed a brief period (phase 4) during which the opercular pressure is positive with respect to the pressure in the buccal cavity. This will tend to cause a reversal in the direction of flow of water across the gills and is probably of importance in bringing about closure of the opercular valve. Thus, with this exception, we have been able to confirm van Dam's suggestion that flow of water across the gills is continuous, in spite of its discontinuous inflow to the buccal cavity and outflow from the opercular cavities.

Results obtained with the roach (*Leuciscus rutilus*) and tench (*Tinca tinca*) were in general agreement with those described above, although the negative pressure in the buccal cavity was larger in amplitude. Variations of this and other types were most common in the tench, where the negative pressure in the buccal and opercular cavities were sometimes equal.

Measurements of the volume of water flowing across the gills, together with simultaneous determinations of the mean pressure-difference, have made possible the calculation of values for the resistance of the gills. An increase in minute-volume, caused by raising the carbon dioxide tension in the water breathed, is largely achieved by a greater stroke-volume and is accompanied by a fall in gill resistance.

Further details of this work will be published shortly.

G. M. HUGHES
G. SHELTON

Department of Zoology,
Cambridge. Dec. 8.

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Purkinje Shift and Retinal Noise

THE Purkinje shift is the displacement of the maximum sensitivity of the eye towards the blue end of the spectrum at low levels of ambient illumination. It occurs in a wide variety of vertebrates, including some which possess the porphyropsin

system of freshwater fishes in place of the rhodopsin system of sea-water fishes and land vertebrates; but in spite of this widespread occurrence, there is no satisfactory explanation for the advantage derived from evolving different photosensitive systems with different spectral sensitivity curves for use at high and low levels of illumination. An explanation is not to be found in the different distribution of energy in the incident light in day-time and at night, for the maximum energy of light from the Moon is slightly to the red side of the maximum for light from the Sun. Le Grand[1] suggests that rhodopsin was evolved by deep-sea fishes, for the light which penetrates deep into the sea has a maximum energy close to the peak of the absorption of rhodopsin, but a shift of the spectral sensitivity curve to the blue may enable the eye to achieve greater sensitivity for a quite different reason.

Recent work[2] has shown what factors control the ultimate sensitivity of detectors of radiant energy working at the limit set by radiation noise from their surroundings. In particular, it has been shown[3] that the sensitivity can be greatly improved by reducing to a minimum the response of the detector to wave-lengths longer than those contained in the signal. The sensitivity of the human eye is probably not limited by radiation noise, but reasons have been advanced elsewhere[4] for believing that it may be limited by the thermal decomposition of rhodopsin molecules. de Vries[5] pointed out that a shift of spectral sensitivity to the blue would reduce the rate of thermal decomposition, so that this may be as beneficial to the sensitivity of the eye as it is to detectors limited by radiation noise. This conclusion is reached as follows.

Stiles[6] has shown that the spectral sensitivity curve of the human eye at the red end of the visible spectrum can be partially accounted for on the hypothesis that the photochemical change which activates a rod requires a certain definite minimum energy which is not entirely derived from a quantum of absorbed radiation, but is supplemented by thermal energy supplied by collisions with the surrounding molecules. If thermal energy can supplement radiant energy, it is natural to suppose that, occasionally, it may be sufficient to activate a rod without the absorption of any radiation. Unfortunately, it is not possible to calculate the absolute rate of such thermal excitations; but it is possible to show how the rate would be affected by varying the minimum energy (E) required for the photochemical change which causes rod excitation. It is assumed that a change of E does not affect the availability of thermal energy to the site in the rhodopsin molecule which is linked to the mechanism of rod excitation, and that it does not change the maximum extinction coefficient of the molecules, but that it does change the position of maximum absorption (λ) so that $hc/\lambda = E$ (that is, one quantum of maximum visibility radiation provides exactly the minimum energy). Following Stiles's assumptions, the fraction of molecules (F) with energy greater than E is given by the expression:

$$F = \exp(-E/kT) = \exp(-hc/\lambda kT)$$

where h is Planck's constant, c the velocity of light, k Boltzmann's constant and T the absolute temperature. If other conditions are the same, the smallest number of quanta which must be absorbed for a given reliability of detection will be proportional to the square root of the rate of the thermal reaction, so that the threshold energy (I) is given (in arbitrary units) by:

$$I.\lambda = F^{1/2} = \exp(-hc/2\lambda kT)$$

On changing E from E_0 to E_1, the position of the peak of sensitivity changes from λ_0 to λ_1, and the ratio of threshold energies at the two wave-lengths is given by:

$$\frac{I_1}{I_0} = \frac{\lambda_0}{\lambda_1} \exp \frac{hc}{2kT}\left(\frac{1}{\lambda_0} - \frac{1}{\lambda_1}\right)$$

For $\lambda_0 = 550$ mμ, $\lambda_1 = 541$ mμ, $I_1/I_0 = \frac{1}{2}$, so the rather surprising conclusion is reached that, in the middle of the visible spectrum, a shift of the spectral sensitivity curve by 9 mμ towards the blue allows the threshold energy to be halved. For a shift from the peak of the photopic (560 mμ) to the peak of the scotopic visibility curve (507 mμ), the theory predicts an improvement of 65 times, and for the shift from the red receptor (580 mμ) to the rods (507 mμ) an advantage of 265 times.

Wald[7] compared the sensitivity of rods lying 8° from the fovea with the sensitivity of cones lying at the fovea, using a test stimulus 1° in diameter exposed for 1/25 sec., and found that the rods were 225 times more sensitive at their peak wave-length than the cones were at theirs. The theory therefore seems to give a correct estimate of the order of magnitude of the advantage derived from curtailing the sensitivity of the receptors on the long wave-length side, and one could scarcely hope for more exact agreement without taking into account many other factors, such as the type of test stimulus used, the concentrations of the photosensitive substances involved, and Lewis's[8] further development of Stiles's theory.

If it is accepted that thermal decomposition of rhodopsin is an important factor limiting the absolute sensitivity of the eye, then the above argument points to the following additional conclusions: (*a*) photosensitive substances sensitive to longer wave-lengths than rhodopsin are likely to be much less stable, and this may be the cause of the lower sensitivity of the cones which contain them; (*b*) the decreased rate of thermal breakdown that can accompany a shift of spectral sensitivity to the blue may be the factor of survival value that explains the evolution of the Purkinje shift.

H. B. Barlow

King's College, Cambridge. Oct. 24.

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Vacuolar Degeneration of Rat Liver Cells by Electron Microscopy

Biochemical studies on the vacuolar degeneration of rat liver cells have been carried out in this Institute during the past three years. Total and residual nitrogen fractions, cateptic and transaminase activities, acid-soluble SH-groups, intra- and extra-cellular water fractions have been studied on normal and vacuolated rat liver. Vacuolation was obtained by

keeping the animals in an atmosphere of 3 per cent oxygen + 97 per cent nitrogen for 2 hr. No changes were observed in the nitrogen and water fractions, in cateptic and transaminase activities, in SH-groups, or deoxyribonucleic and ribonucleic acid contents; only some of the soluble phosphorus fractions were diminished. These results therefore seem to lead to the conclusion that the cytoplasmic lesions are not so serious as one would expect them to be from the morphological appearance of the vacuolated cells. In fact, the cytoplasm of these cells appears deeply damaged in stained sections and contains several vacuoles of different size, which may sometimes reduce the cytoplasm to thin strands between the vacuoles. However, observations carried out with a phase-contrast microscope on isolated living liver cells from animals kept in hypoxia indicate that vacuoles are not visible in non-fixed, unstained cells. This seems to suggest that the appearance of these vacuoles is linked in some way with fixation of the damaged cells: it could be an artefact due to the action of the fixatives commonly used in histology on the cytoplasmic structures.

In an attempt to elucidate these apparently contradictory findings and to demonstrate more clearly the cytoplasmic structure of the damaged cells, a morphological study has been undertaken on thin sections of normal and hypoxic rat liver. Preliminary results obtained by electron microscopy are presented here.

The animals were killed by decapitation, small pieces of liver quickly removed and placed in a buffered solution of 1 per cent osmic acid. The fixation and dehydration were carried out according to the technique of Sjöstrand[1]. Specimens were embedded in a mixture of butylmethacrylate + 5 per cent methylmethacrylate, containing 1 per cent 2,4-dichlorobenzoylperoxide. Polymerization was achieved by keeping the samples in an oven at 45° C., as described by Newman, Borysko and Swerdlow[2]. The electron micrographs were obtained with a Siemens electron microscope.

These initial studies on liver cells from hypoxic rats do not permit one to draw definitive conclusions about the ultrastructure of cytoplasm in the damaged cells. However, some preliminary observations can already be made. As can be seen in Fig. 2, in hypoxic liver cells the ground substance tends to disappear, while the elements of the cytoplasmic reticulum appear enlarged and considerably swollen in places, with a tendency to form large cysternæ. On the whole, the cytoplasmic structure seems loosened and the lamellæ tend to be disrupted. Vacuoles have not yet been observed. One may perhaps assume that the vacuoles which appear in normally stained sections may be derived from this loosened cytoplasmic structure. However, not enough cells have as yet been observed to permit a definite conclusion on this point. Mitochondria do not appear to be either swollen or damaged, although it is possible that their function may be impaired by the altered cellular medium.

Further studies are now in progress, in order to clarify the question of whether or not vacuoles in hypoxic cells are artefacts, and to see if alterations of the mitochondria and cellular membrane also occur.

Maria Bassi
Aldo Bernelli-Zazzera
Institute of General Pathology,
University of Milan. Nov. 3.

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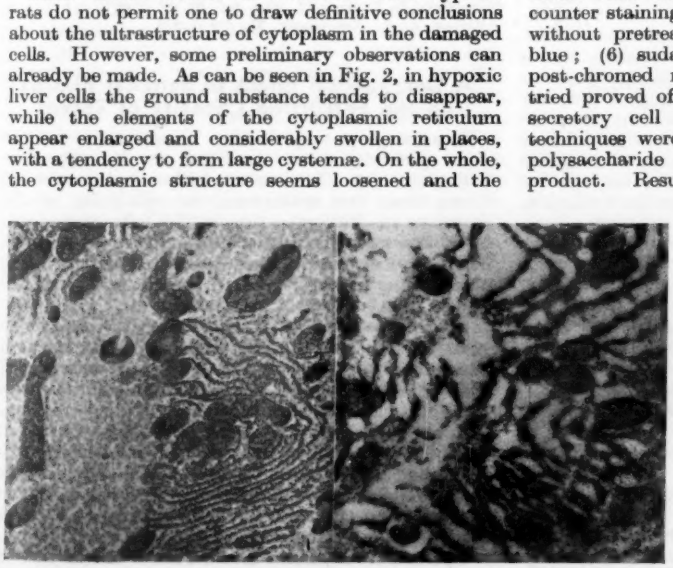
Neurosecretory Cells in the Brain of the Larva of *Lucilia caesar* L.

Brain neurosecretory cells have now been described in a large number of pterygote insect species. Most authors are agreed that there are normally two groups of these identifiable in each hemisphere of the brain, a median group lying close to the pars intercerebralis and a lateral group. In larvæ of Diptera-Cyclorrhapha descriptions exist of the former only (see Thomsen[1]).

Observations have now been made of the neurosecretory cells of the brain of the larva of *Lucilia caesar* L. Serial sections of brains of larvæ in diapause and at five stages in development without diapause, from feeding third instar to cryptocephalic pupa, have been stained with the following procedures: (1) Chrome–hæmatoxylin of Gomori[2] and (2) paraldehyde–fuchsin of Gomori[3], both after oxidation with acidified potassium permanganate; (3) Steedman's[4] alcian blue with neutral red, with hæmalum–eosin counter staining; (4) periodic acid – Schiff with and without pretreatment with diastase; (5) toluidine blue; (6) sudan black *B* in formol-calcium fixed post-chromed material. Other staining methods tried proved of little value in distinguishing neurosecretory cell groups. The carbohydrate-staining techniques were used in the hope of identifying a polysaccharide component of the neurosecretory product. Results were, from this point of view, inconclusive, but were valuable in demonstrating that there are cytochemical differences between neurosecretory cell groups and identity within groups.



(1) Normal rat liver cell; (2) hypoxic rat liver cell. × 9,000

No fewer than six groups of neurosecretory cells can be identified in the brain of the *L. caesar* larva, distinguishable by criteria of position, size, morphology and staining characteristics. The following descriptions refer to the cells in one half of the brain only.

Group 1. This consists of two large neurones, attaining a maximum size in a diapause larva of 18μ × 40μ. In sections stained with paraldehyde–fuchsin the smallest particles of the neurosecretory pro-

duct are at the limit of resolution of the light microscope. These particles form aggregates, but in this group the largest aggregates do not exceed 1μ in size. In the diapause brain, these cells assume a uniform grey-blue colour with chrome–hæmatoxylin, and have a marked affinity for alcian blue while the product is not positive to periodic acid – Schiff reagent. The cell stains metachromatically, a deep purple colour being produced with toluidine blue. Accumulation of the product starts at the cessation of feeding and within a few days the cell is greatly distended. It remains in this state throughout the diapause phase, the product being retained presumably until the end of diapause.

Group 2. A single cell lying anterior to group 1; this measures 15μ × 20μ. Accumulation of the product starts at about the same time as in group 1, but in paraldehyde–fuchsin sections the group 2 cell is characterized by the fact that in it the product collects in very large aggregate masses. This group is not differentiated by alcian blue or periodic acid – Schiff procedures, but does show purple metachromasia, though the colour is less intense than in group 1.

Group 3. The four cells of this group, measuring about 15μ × 20μ, with a central nucleus, are the only ones showing the distinct blue secretory granules of an actively secreting cell in diapause brains stained with chrome–hæmatoxylin. A discharge picture is also obtained in these brains with paraldehyde–fuchsin. They are undifferentiated by the other procedures, and are the only neurosecretory cells orthochromatic with toluidine blue. In the non-diapause larva, accumulation of the product does not start in these cells until late in the pre-pupation phase.

Group 4. Although cells of this group intermingle with those of group 3, they are morphologically distinct. Measuring about 17·5μ × 25μ, they are distinctly pyriform, with the nucleus displaced to the axon end of the cell. In diapause brains they are without granules, but the abaxonal zone of the cytoplasm colours a uniform light purple with paraldehyde–fuchsin, and with other procedures is phloxinophil, eosinophil and uniformly positive to the periodic acid – Schiff reagent. With toluidine blue a purple/red metachromasia develops. In non-diapause larvæ, accumulation starts in this group at the time of completion of crop evacuation after the cessation of feeding, and a clear discharge picture is obtained at a time when the development rate of imaginal disks is rapidly increasing, that is, at the time of thoracic gland activation. Before puparium formation, however, these cells have reverted to the state found in the diapause larva, presumably the resting state.

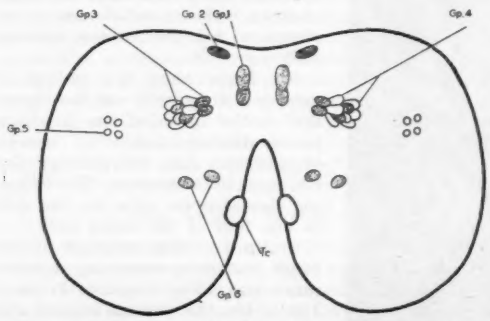


Fig. 1. Distribution of neurosecretory cell groups in the brain of *L. caesar* larva. *tr* main cerebral trachea

Group 5. These small, almost spherical cells, about 12·5μ in diameter, lie lateral to and behind group 4. The nucleus is about the same size as in the other neurosecretory cells, 8μ in diameter, and there is therefore relatively little cytoplasm. The cytoplasm stains like that of group 4, except that a stronger uniform positive periodic acid – Schiff reaction is obtained. The cytoplasm is uniformly and strongly sudanophil, whereas in other groups sudanophil material is irregularly distributed. Accumulation and discharge are, in this group, synchronous with these activities in group 4.

Group 6. There are two cells of irregular outline, about 17·5μ × 20μ in size, which lie against the medulla at the rear of the brain close to the insertion of the main cerebral trachea. In the diapause brain they possess granules like those in group 1 but staining a lighter colour with paraldehyde–fuchsin and in much lower concentration. They are not differentiated by the other staining procedures. With paraldehyde–fuchsin staining they are also detectable in the pre-pupation phase.

Thus there are six groups of neurosecretory cells in the brain of *L. caesar* larva. It seems probable that the neurosecretory material demonstrable in the corpus cardiacum of a diapause larva originates in cells of group 3. If, as Hinton[5] suggests, 'a diapause hormone' exists, then this group is the likeliest source. Only groups 4 and 5 are totally devoid of a neurosecretory product during diapause and at pupation, while at the time of activation of the thoracic glands they are discharging such a product. It can therefore be postulated that these two groups only are responsible for the promotion of thoracic gland activity.

Alastair Fraser

Zoology Department,
University, Glasgow, W.2. Nov. 7.

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A Detrimental Effect of Seminal Plasma on the Fertilizing Capacity of Sperm

Rabbit sperm only develop a capacity to fertilize after spending about six hours in the uterus or Fallopian tube. This has been shown by transferring sperm from the epididymis, an ejaculum, or the uterus to the Fallopian tube[1]. The following experiment shows that fertilizing capacity developed in the uterus is lost when sperm is treated with seminal plasma, but can be recovered after a further period in the female tract.

'Capacitated' sperm were obtained from rabbits that had either been mated normally or inseminated with epididymal sperm. The uteri were each flushed with 5 ml. saline, and washings from one doe were combined and divided into two equal portions. Seminal plasma (from centrifuged fresh ejaculates) was added to one portion and both were then centrifuged at 3,200 rev./min. for 30 min.; the supernatant fluid was discarded. Sperm treated with undiluted plasma were suspended in 0·5 ml. plasma after centrifugation of the uterine washings.

Sperm were deposited into the tubes of does treated with gonadotrophin either 12 or 4 hr. earlier (that is,

Table 1. Detrimental Effect of Seminal Plasma on the Fertilizing Capacity of Rabbit Uterine Sperm

Concentration of different seminal plasma	No. of rabbits	No. of uterine sperm deposited (range)	Left tube, experimental			Right tube, control		
			Total ova	Fertilized ova	Fertilization (per cent)	Total ova	Fertilized ova	Fertilization (per cent)
Rabbit								
Undiluted	4 + 3*	73,000–275,000	23	0	0	41	24	59
20 per cent	8	19,000–220,000	33	1	3	32	19	59
10 „ „	8	52,000–208,000	36	2	6	26	17	65
5 „ „	7 + 3*	15,000–139,000	38	0	0	47	25	53
2 „ „	6	3,000–255,000	36	18	50	31	26	84
Bull								
2 „ „	6	12,000–55,000	18	1	6	22	14	64
Human								
5 „ „	6	29,000–55,000	22	6	27	18	14	78
Rabbit								
5 or 10 per cent deposited 6 hr. before ovulation	8	55,000–303,000	29	17	59	35	23	66

* Received uterine sperm obtained by insemination of epididymal sperm

2 hr. after, or 6 hr. before, the expected time of ovulation). Each doe received sperm treated with seminal plasma in the left tube and the control capacitated sperm in the right tube. If sperm samples showed no motility they were not used. The number of sperm inseminated was estimated from hæmocytometer counts. One day later, ova were recovered, mounted *in toto* on a slide, fixed and stained[2]. The results are presented in Table 1.

The following points are noteworthy: (1) Capacitated sperm treated for 30 min. with rabbit seminal plasma at 10 or 20 per cent concentration seem to have fertilized three ova; but this may be due to accident, since 5 per cent plasma destroyed fertility and 2 per cent caused significant loss of fertilizing capacity. (2) Seminal plasma of the bull (2 per cent) damaged fertilizing capacity more than did 5 per cent human plasma; rabbit plasma appears to be of intermediate potency. (3) Though sperm treated with 5 or 10 per cent rabbit plasma were very poorly fertile if inseminated after ovulation, they were quite fertile when inseminated 6 hr. before ovulation—that is, fertilizing capacity lost on treatment with seminal plasma can be restored in the Fallopian tube if the treated sperm stay there for 6 hr. (4) The motility of sperm treated with seminal plasma was, as a rule, poorer than that of untreated samples. (5) The numbers of sperms deposited into individual tubes varied and (within a group) the proportion of ova fertilized may be related to the number of sperm; however, between the left and right tubes (treated and control sperm) a higher proportion of ova fertilized in the right tube is not correlated with a higher number of sperm deposited there. (6) Unfertilized ova often had sperm on the zona pellucida (55 per cent exposed to untreated sperm, and 86 per cent of ova when the sperm had been treated with plasma). There were more sperm on the zonæ of eggs that had been fertilized (11·2 *versus* 5·1 with treated sperm; 10·3 *versus* 2·8 for controls). It seems that though a relatively large number of sperm in the vicinity of the egg increases the chance of fertilization, failure of fertilization by treated sperm is due not to lack of numbers but to incapacity of the sperm to penetrate the zona.

Rabbit seminal plasma, in 25 per cent concentration in serum, is harmful to fertilized ova[3]. But in view of the low concentration of plasma placed in the tubes, and the normal appearance of the ova recovered, the possibility seems to be excluded that the seminal plasma acted by rendering the tubal ova unfertilizable. However, the substance affecting capacitated sperm may be similar to that which is harmful to fertilized ova, because bull, rabbit and human seminal plasmas have similar relative potencies in each case.

Capacitation appears not to be a simple process of elimination by the female tract of adherent seminal plasma; for epididymal sperm has to be capacitated[1]. Previous contact with seminal plasma has no relation to its subsequent detrimental effect after capacitation, since capacitated epididymal sperm were incapacitated by seminal plasma (see Table 1). Seminal plasma as a medium for artificial insemination is beneficial to both motility and fertility[4]. Yet after capacitation in the female tract seminal plasma is detrimental both to motility and fertilizing capacity. It seems that the metabolism of sperm is much altered by contact with the uterine lumen.

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M. C. Chang
Worcester Foundation for Experimental Biology, Shrewsbury, Mass. Oct. 10.

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Lipolytic Effect of the Injection of Adrenaline on Fat Depots

Fat is mobilized from the fat depots under various conditions; but the form in which it is delivered to the blood is not known. Investigations have shown that both neutral fat (Carlson, L. A., and Wadström, L. B., unpublished work) and unesterified fatty acids[1] are increased in the serum during starvation in man.

Recent investigations made by Dole[2] and Gordon and Cherkes[3] have shown that injection of adrenaline causes an increase in the content of unesterified fatty acids in the serum. Evidence for an intimate relation between injection of adrenaline and mobilization of depot fat has been given by several authors[4].

These findings might indicate that the depot fat is at least partly mobilized as unesterified fatty acids. If this assumption is correct, a lipolysis of the stored neutral fat in the depot probably occurs. It is known from lipolytic systems, for example, pancreatic lipase acting upon fat emulsions[5] and clearing factor upon chylomicrones (Carlson, L. A., and Wadström, L. B., unpublished work), that the concentration of lower glycerides is increased during the lipolytic process.

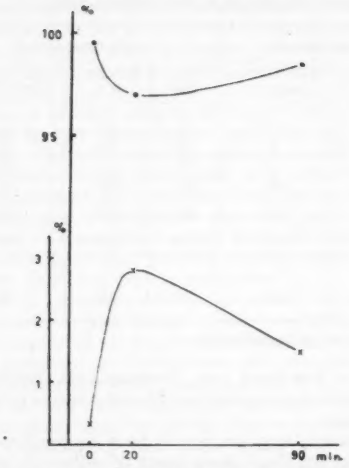

Fig. 1. Percentage composition of glycerides from fat depot before and after injection of adrenaline. ●——●, Triglycerides; ×——× di- and mono-glycerides

Some experiments have been carried out in this laboratory in order to ascertain if the neutral fat is hydrolysed in the depots after injection of adrenaline. The results of one of these experiments are given in Fig. 1. A male rabbit (3,500 gm.) was given 0·01 mgm. adrenaline intravenously. Subcutaneous fat from the pubic region was taken before and 20 min. and 90 min. after the injection. Tri-, di- and mono-glycerides were determined by the method of Borgström[6].

The percentage composition of the depot glycerides is given in Fig. 1. The increase of the lower glycerides found in this experiment indicates that injection of adrenaline activates a lipolysis of the depot neutral fat. Essentially similar results have been obtained in other experiments.

Lars B. Wadström

King Gustaf V Research Institute and
Department of Surgery,
Karolinska Sjukhuset,
Stockholm 60.

Nov. 9.

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Inhibition of Fibrinolysis *in vivo* by feeding Cholesterol

We have produced[1], by the technique of Grossi, Cliffton and Cannamela[2], a clot in the marginal vein of the ear of rabbits and found that these clots lysed in 8–39 hr., the mean being 20 hr. with a standard deviation of 8 hr. A biopsy specimen of the vein was taken 48 hr. after production of the thrombosis, and on histological examination in every case the vein appeared normal. Extending these observations, we have found (unpublished) that the lysis was due to the production of fibrinolysin locally in the vein, and that it still occurred even when the thrombosed segment of vein was ligatured above and below the thrombus and all visible veins draining into it occluded by cautery. We have shown that the lysis of such clots can be prevented by the administration of corticotropin[1].

Greig[3] has reported the inhibition in humans of spontaneous fibrinolytic activity of the plasma by a fatty meal. As pointed out by Fearnley[4], this spontaneous fibrinolytic activity is of a very low order. We would emphasize, too, that there is no evidence that the spontaneous fibrinolytic activity *in vitro* of the plasma of a specimen of venous blood represents the fibrinolytic activity which may arise *in vivo*. For example, in the rabbit, while clotted whole blood is being rapidly lysed in the marginal vein of the ear, no spontaneous fibrinolytic activity can be demonstrated by the low-temperature technique[5] in the plasma of blood removed from another vein. An investigation of the effect of feeding cholesterol on the lysis of clots experimentally produced *in vivo* would be free from both these criticisms.

Twenty-one adult white rabbits were fed cholesterol in doses of 1 gm. per kgm. of body-weight daily. On the tenth day a clot was produced in the marginal vein of one ear by the technique of Grossi, Cliffton and Cannamela[2]. The thrombosed segment of the vein was observed at intervals by transillumination, and the time taken for a free flow of blood to be established through the segment was recorded. A biopsy of the segment of vein was taken ten days after production of the thrombosis. In 30 per cent of the animals a free flow was established within the range encountered in control animals. On histological examination the veins were normal. In the remaining 70 per cent, free flow was established in 72–122 hr., the mean being 86 ± 7 hr. On histological examination the veins were abnormal. The thrombus in each case had become organized and this had resulted in variable and irregular thickening of the intima. In the interstices of the granulation tissue 'foam' cells were present in varying numbers.

These observations establish that the feeding of cholesterol to rabbits inhibits the fibrinolytic activity normally induced by the production of a clot in the marginal vein of the ear.

There are two major and apparently conflicting hypotheses concerning the etiology of atherosclerosis. Among others, Keys[6] emphasizes the importance of dietary fats, whereas Duguid[7], whose observations have been confirmed by others[8], holds that the initial phase of development of atherosclerosis is the occurrence of mural thrombi. Greig[3] suggested that a common ground between these two hypotheses might be found in the influence of lipæmia on fibrinolytic activity. Our observations support this suggestion.

H. C. Kwaan
A. J. S. McFadzean

University Department of Medicine,
Queen Mary Hospital,
Hong Kong.

Oct. 31.

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Effect of Ethisterone, β-Œstradiol and Progesterone on the Phagocytic Activity of the Reticulo-Endothelial System

THE reticulo-endothelial cells are known to form an important part of the defence mechanism of the body against infection. At the site of acute infections, neutrophil leucocytes attack the invading organisms while the reticulo-endothelial macrophages phagocytose the dead bacteria and dead tissue cells. In chronic infections such as tuberculosis, the phagocytic activity of the macrophages forms the main line of defence against the invading organisms. Further, there is much circumstantial evidence in both acute and chronic infections to show that the reticulo-endothelial cells raise the humoral resistance of the patient by the production of antibodies. It has already been demonstrated that the phagocytic activity of the reticulo-endothelial system is stimulated by œstrogens[1]; that cortisone[2], testosterone, androstene-3β-17α-diol[3] depress the phagocytic activity; and that deoxycorticosterone[4] has no appreciable effect.

The present communication deals with the effects of ethisterone, β-œstradiol and progesterone. Forty-three male guinea pigs were used. The reticulo-endothelial macrophages were studied by giving all the animals one daily injection of trypan blue subcutaneously for the last six days prior to being killed by chloroform. The dosage of the dye was calculated on the basis of 0·8 ml. of a 1 per cent solution in distilled water per 100 gm. body-weight. Seven of the animals were given dye only and were used as controls. The hormone treatment given to the remaining thirty-six animals is shown in Table 1.

Table 1. HORMONE TREATMENT GIVEN TO THIRTY-SIX ANIMALS

No. of animals	Hormone used	Daily dose intra-muscularly	Duration of treatment
6	Ethisterone (Organon) dissolved in ethyl oleate	0·5 mgm.	2 weeks
6	Ethisterone (Organon) dissolved in ethyl oleate	0·5 mgm.	4 weeks
6	β-(Estradiol (Organon) dissolved in ethyl oleate	0·5 mgm.	2 weeks
6	β-(Estradiol (Organon) dissolved in ethyl oleate	0·5 mgm.	4 weeks
6	Progesterone (Organon) dissolved in ethyl oleate	5·0 mgm.	2 weeks
6	Progesterone (Organon) dissolved in ethyl oleate	3·0 mgm.	3 weeks

Specimens were taken from the spleen, liver and lymph nodes and fixed in Heidenhain's Susa fluid. Sections were cut at 10μ thick and stained with weak eosin, dilute carbol fuchsin or alum carmine. The activity of the reticulo-endothelial system in the organs studied was assessed by the number of dye-bearing cells and the intensity of the vital staining.

In the animals which received ethisterone and β-œstradiol, a moderate number of dye granules was present in the macrophages of the spleen, liver and lymph nodes and the vital staining appearances closely resembled those in the control animals. In the six animals which received 3 mgm. of progesterone daily for three weeks the vital staining appearances were similar to those of the controls. In the group which received 5 mgm. of progesterone daily for two weeks, four showed vital staining appearances similar to the controls, while the remaining two animals showed reduced activity of the macrophages.

The results, therefore, suggest that, in the male guinea pig, ethisterone, β-œstradiol and progesterone have little or no effect on the activity of the reticulo-endothelial system and in this respect differ greatly from the œstrogens.

The substances used in these investigations were provided by Dr. Tindall, of Organon Laboratories, Ltd., to whom we offer our grateful thanks.

T. NICOL
R. S. SNELL

Department of Anatomy,
King's College,
London, W.C.2. Nov. 9.

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Isolation of Nigerose from Floridean Starch

IT is generally agreed that the iodine-staining polysaccharide isolated from many red algae is a glucan of the amylopectin type in which the chain-forming links are α-1 : 4 and the branch links, α-1 : 6-glucosidic. The floridean starch from *Dilsea edulis* appears to differ, in finer details of structure, from one sample to another. This difference turns mainly on the presence or the absence of a third type of link, namely, the 1 : 3-glucosidic linkage[1]. The majority of investigations favour the view that 1 : 3-glucosidic linkages are in fact not present in *Dilsea* starch[2]. We therefore think it desirable to record some observations made in the course of a comprehensive linkage analysis of floridean starch which establish that a small proportion of 1 : 3-links is an integral part of the starch structure and, moreover, that these links have the α-configuration.

Floridean starch was extracted from *Dilsea edulis* by the method of Barry *et al.*[1] and was purified by precipitation with iodine[2] and by use of cetyl trimethyl ammonium bromide ('Cetavlon') to precipitate a galactan sulphate impurity[4]. The starch (92·5 per cent polyglucose) had $[\alpha]_D^{18}$ + 187° (water) and blue value, 0·065. The starch (12·5 gm.) was hydrolysed by 0·33 *N* sulphuric acid (1·25 litres) at 100° to the stage of an apparent conversion into glucose of 53·4 per cent (2·15 hr.). After being cooled, neutralized and concentrated, the hydrolysate was chromatographed on a column of charcoal–'Celite'[5]. Glucose was the only monosaccharide obtained, but the disaccharides were readily separated into two fractions, the first consisting almost entirely of *iso*maltose (289 mgm.), characterized as its β-octa-acetate (melting point 142·3°; $[\alpha]_D^{18}$ + 96·9° in chloroform). The second disaccharide fraction was mainly maltose but contained a small amount of another disaccharide, which was separated from the maltose by taking advantage of its greater electrophoretic mobility in borate buffer[6]. The amorphous solid obtained (34·6 mgm.) migrated as a single substance during both paper chromatography and electrophoresis and had mobilities in each system identical with those of authentic nigerose. It showed $[\alpha]_D^{18}$ + 136·9° (water) and its β-octa-acetate had melting point and mixed melting point 147–48° and

$[\alpha]_D^{18}$ + 86·6° (chloroform). The trisaccharide fractions contained maltotriose and panose (characterized as panitol dodeca-acetate (melting point, 147·8°; $[\alpha]_D^{18}$ + 119° in chloroform). In addition, a mixture of trisaccharides was obtained which, on partial hydrolysis, yielded maltose, *iso*maltose and nigerose among the products. The yield of nigerose (34·6 mgm.) is much greater than would be expected from acid reversion, control experiments having shown that an equivalent weight of glucose, heated under the same conditions, gives rise to less than 2 mgm. of nigerose[7].

These experiments indicate that a small proportion of α-1 : 3-linkages exists in floridean starch in addition to the linkages expected of an amylopectin. It should be noted that a small proportion of α-1 : 3-linkages has also been detected in waxy-maize amylopectin[8].

Stanley Peat
J. R. Turvey
J. Môn Evans

University College of North Wales,
Bangor. Nov. 21.

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Separations of Carbohydrates on Charcoal Columns in the Presence of Molybdate

The elution of certain carbohydrates from charcoal–'Celite' columns by aqueous ethanol is accelerated when the column is impregnated with, and the eluent contains, borate ions in an alkaline environment[1].

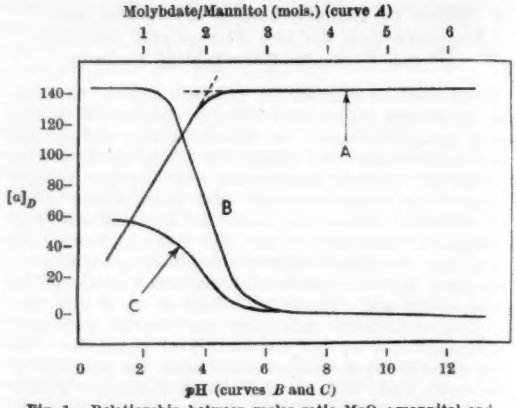

Fig. 1. Relationship between molar ratio MoO_3 : mannitol and $[\alpha]_D$ at pH 2·1 (curve *A*). Effect of pH on the $[\alpha]_D$ of 15 per cent aqueous mannitol solutions containing molybdate (molar ratios $MoO_3 : C_6H_{14}O_6$ = 3·13 : 1 (curve *B*) and 0·75 : 1 (curve *C*))

Only those carbohydrates which form strong complexes with borate ions are appreciably affected in this manner. A wider applicability of this technique for fractionating carbohydrate mixtures would ensue if complexing agents other than borate ions could be employed in neutral and acidic media. It is known[2] that chromate, molybdate and tungstate ions react with polyalcohols and cause changes in their specific rotations. The influence of *p*H on the specific rotations of aqueous solutions of mannitol which separately contain these ions has been investigated. By far the greatest change in the specific rotation occurs in the presence of molybdate ions, and it is a maximum at *p*H less than about 2·5 (Fig. 1). A maximum of two molybdate ions may complex with each mannitol molecule (Fig. 1) (cf. ref. 2).

For comparison with previous results with borate-impregnated columns[1] a mixture of maltose and melibiose was eluted from a charcoal–'Celite' column

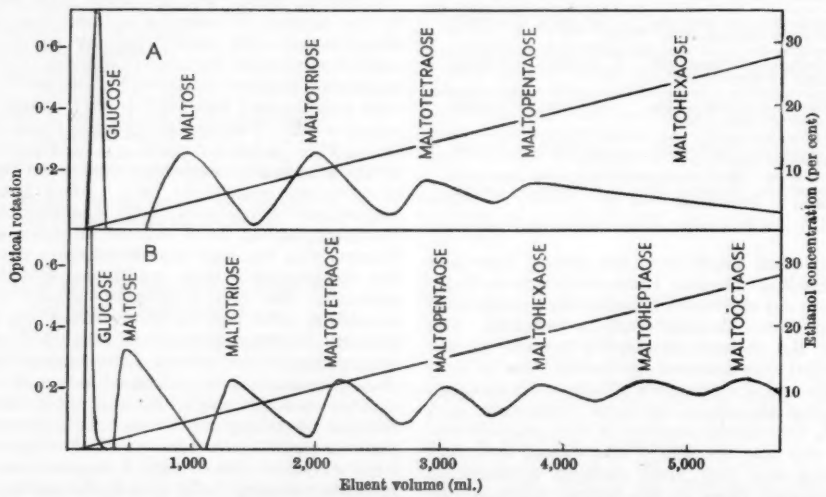

Fig. 2. Behaviour of the maltose series of oligosaccharides on a charcoal–'Celite'–molybdate column. *A*, control; *B*, column impregnated with molybdate. Eluent contained 2·5 per cent sodium molybdate acidified to *p*H 3·0. Column *B* was impregnated by washing it with the molybdate solution until no further molybdate was absorbed. Molybdate could be removed from the eluate which contained the saccharides by passage down (1) a charcoal–'Celite' column after neutralization to *p*H 7, or (2) a mixed bed of 'Zeokarb 225' (H^+ form) and 'Amberlite *IR*-4*B*' (OH^- form)

impregnated with molybdate. The eluent comprised an aqueous molybdate solution of constant molarity but of increasing ethanol content. While the melibiose was largely unaffected by the presence of molybdate the elution of maltose was accelerated. The reverse effect occurs with the borate-impregnated columns, which suggests that borate and molybdate ions complex across different positions and could therefore be used in separations of different pairs of sugars. This aspect is being examined.

The separation of the maltose series of oligosaccharides is also accelerated and improved in the presence of molybdate (Fig. 2), so that the higher members become available more readily. The use of molybdate for this purpose is analogous to that of borate in the case of the *iso*maltose series of oligosaccharides[1]. Preliminary experiments indicate that carbohydrates can be absorbed also on an ion-exchange resin ('Deacidite *FF*') in the molybdate form. This is of interest since it is known[1] that methods involving charcoal and anion exchange resins for the separation of borate complexes of carbohydrates are largely complementary.

During the course of this work, Frahn and Mills[3] reported briefly studies of the paper-ionophoresis of hexitols and saccharides in tungstate and molybdate solutions and Whelan (personal communication) has developed a similar method independently.

We are indebted to Prof. M. Stacey for his interest. One of us (R. B. W.) thanks the British Rayon Research Association for the award of a scholarship.

S. A. Barker
E. J. Bourne*
A. B. Foster
R. B. Ward

Chemistry Department,
The University,
Edgbaston, Birmingham 15.
Nov. 7.

* Present address: Royal Holloway College (University of London), Englefield Green, Surrey.

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Molecular Weight of Deoxyribonucleic Acids from Various Sources

A GREAT amount of research work concerning the study of the molecular characteristics of a deoxyribonucleic acid from various sources has been carried out in the past few years. Generally, cell nuclei, bacteria or phages are treated by a proper method the result of which is to obtain the deoxyribonucleic acid particles in a suitable solution. It is then possible to precipitate the acid from this solution, to stretch fibres of it, and study its X-ray diagram. Furthermore, one can determine the molecular weight and radius of gyration of the particles in solution through light-scattering measurements.

The essential question which is raised is to know to what extent the particles in solution are similar to the molecules *in situ*.

Here we are considering only the case of the molecular weight. From the whole mass of data obtained so far in several laboratories as well as in ours, and which are put together in Table 1, a few conclusions can be drawn.

In some cases, apparently identical methods of extraction applied to the same living tissue yield deoxyribonucleic acid of different molecular weights; in other cases different methods lead to the same molecular weight. But the point which seems to us most significant is that the molecular weights are not distributed randomly.

Table 1

Sample	Organ	Author	Method	M.W. ($\times 10^6$)	Ref.
B.G.	Calf thymus	B. Bunce	Gulland	3·5	1
SX	Calf thymus	R. Bütler	Signer	3·8	2
CV42	Calf thymus	Vendrely	Signer	4·0	3
CV49	Calf thymus	Vendrely	Signer	4·5	3
Simmons	Calf thymus	Doty	—	5·8	4
SVII	Calf thymus	Schwander	Signer	5·9	4–6
—	Calf thymus	G. Brown	—	6·0	5
SV	Calf thymus	Schwander	Signer	6·0	6
I69	Calf thymus	Vendrely	Signer	6·0	3
CV74a	Trout sperm	Vendrely	Mirsky	6·0	3
CV69	Calf thymus	Vendrely	Signer	6·0	3
CV71	Calf thymus	Vendrely	Signer	6·0	3
SVIII	Calf thymus	Schwander	Signer	6·0	6
CV74b	Trout sperm	Vendrely	Mirsky	6·0	3
Varin	Calf thymus	Varin	—	6·87	1
—	*E. coli*	Rowen	Kay	7·0	7
Varin	Calf thymus	Varin	Signer	7·7	4–6
Doty–Rice	Calf thymus		—	7·7	4
Brown	*E. coli*	Brown	—	9·1	5
SXII	Calf thymus	R. Bütler	Signer	11·6	2
CV51	Fowl erythrocyte	Vendrely	Signer	11·6	3
CV62	Calf thymus	Vendrely	Signer	13·0	3
CV64	Calf thymus	Vendrely	Signer	13·0	3
I62	Calf thymus	Vendrely	Signer	14·0	3
CV9	Calf thymus	Vendrely	Kay	15·0	3
CV78	Fowl erythrocyte	Vendrely	Signer	15·0	3
CV5	Calf thymus	Vendrely	Signer	16·5	3
Brown	Avian tubercle bacilli	Brown	—	14·0	5

Effectively, Table 1 shows that, among 28 results of experiments, 14, that is, 50 per cent, give a mass situated between $5{\cdot}8 \times 10^6$ and $7{\cdot}7 \times 10^6$, and 9, that is, 33 per cent, a mass situated between $11{\cdot}5 \times 10^6$ and $16{\cdot}5 \times 10^6$, that is to say, approximately double the former value. (The precision of light-scattering determinations of molecular weights is about $\pm$ 15 per cent.)

A second point, likewise, seems to us worth notice: particles of the same weight are obtained in deoxyribonucleic acid prepared from extremely different living organisms: for the molecular weight $6{\cdot}5 \times 10^6$, calf thymus, trout sperm, *Esch. coli*; for the molecular weight 13×10^6, calf thymus, fowl erythrocyte, avian tubercle bacilli. It thus seems possible to draw some interesting conclusions from these observations.

If deoxyribonucleic acid particles contained in the solution are constituted either by the original molecules of the acid (which molecules would have undergone a possible denaturation but no degradation during the extraction), or by aggregates of a small number (a few units) of such molecules, then we are compelled to conclude that all the living species (or at least the species quoted here) contain particles of deoxyribonucleic acid of the same weight (in the range of the precision of measurements). Therefore there would be no correlation between this molecular weight and the differentiation of the species.

Let us recall here that it has been shown that the amount of deoxyribonucleic acid per cell nucleus is nearly the same for whole classes of animal species (fishes, $1{\cdot}8 \times 10^{-9}$; birds, $2{\cdot}2 \times 10^{-9}$; mammals, $5{\cdot}6 \times 10^{-9}$)[6,8]. If the acid molecules are of uniform weight this means that the number of deoxyribonucleic acid molecules per cell nucleus is the same within each of these species. This number should be larger in highly organized species.

One can also assume that the deoxyribonucleic acid particles contained in the solution are aggregates

formed by a great number of original molecules, the weight of which is much smaller than $6 \cdot 5 \times 10^6$, and these aggregates should have definite and identical weight, whatever the extraction method used. Then it would be possible that these small molecules do not have the same weight within each species.

Ch. Sadron
J. Pouyet
R. Vendrely

Centre de Recherches sur les Macromolécules,
6 rue Boussingault,
Strasbourg.
Nov. 19.

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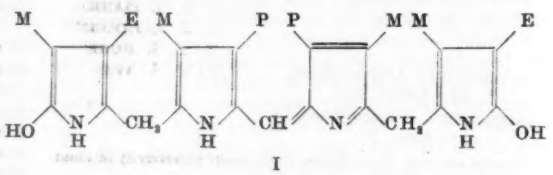
Structure of Stercobilin

Of the three urobilinoid pigments excreted by man (*i*-urobilin, *d*-urobilin and stercobilin), only *i*-urobilin has a structure established by degradation and synthesis[1]. The structure of *i*-urobilin is as shown in (I), except that the end rings, in common with all so-called hydroxypyrroles, are probably lactam in nature[2]. The other two pigments are formally derived from *i*-urobilin by dehydrogenation and tetrahydrogenation respectively[3].

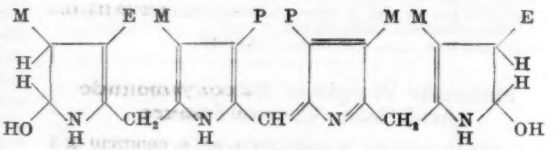
The structure of stercobilin has been investigated in this Department and we now report the isolation of a degradation fragment derived from the end rings in this pigment. From stercobilin, by treatment with dilute chromic acid solution, we have obtained a neutral- and an acid-fraction. The latter consists mainly of hæmatinimide and a crystalline dicarboxylic acid the complete identification of which requires further study. The neutral fraction has an infra-red absorption curve similar to that of synthetic *trans*-methylethylsuccinimide (main characteristics in chloroform: 1,780 s, 1,726 cs, 1,458 m, 1,382 m, 1,347 s, 1,286 m, 1,172 s, cm.$^{-1}$) and behaves identically on paper chromatography. Both the synthetic imide and the natural product have an ultra-violet absorption maximum in ethanol below 220 mμ and the curve in each case shows an inflexion at 248 mμ (E(1 cm., 1 per cent) = 6·2 and 5·5 respectively). *Cis*-methylethylsuccinimide appears to be even more labile than the αα′-dimethyl analogue investigated by Linstead[4], and our attempts to obtain this isomer have resulted in the production of impure *trans*-compound; this has an infra-red spectrum indistinguishable from that of the pure *trans*-substance, so that we are at present unable to demonstrate with certainty the orientation of alkyl groups in our oxidation product.

The IXα-order of side-chains shown in the three possible structures for stercobilin is assumed from the fact that treatment of the pigment with sulphuric acid produces a glaucobilin identical with glaucobilin IXα prepared in an unambiguous way[5]. The oxidation of stercobilinogen (the colourless dihydro derivative) has provided pure hæmatinimide in about 95 per cent of the yield theoretically possible if only one of the rings bearing propionic acid groups were truly pyrrolic. It is difficult to isolate this product in high yield, even from mesoporphyrin. The yield obtained from stercobilinogen is therefore indicative of the probable presence of two such pyrrolic rings. Consistent with this view is the fact that methylethylmaleimide is not obtained by oxidation of stercobilin; yet the pigment resembles *i*-urobilin in showing the absorption maximum characteristic of dipyrryl methenes (about 450 mμ in dioxane)[6]. Since hæmatinimide is stable under the conditions of our oxidation experiments, we conclude that our neutral product originated from the end rings of the stercobilin; these are therefore established with some certainty as the positions of extra hydrogenation.

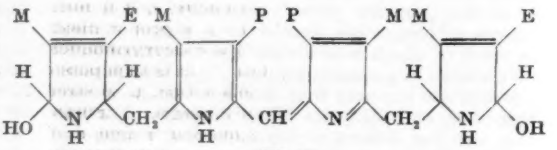
The production of methylethylsuccinimide supports the lactam structure (IV), suggested by Birch[7] as most consistent with the stability of stercobilin, rather than structures (II) or (III), in which the presence of the olefinic double bond would cause the rings to be destroyed on oxidation. Our yields of the imide are low (maximum about 27 per cent) and a further indication of ring destruction is the utilization by stercobilin of about 38 equivalents of oxidation per molecule, 5 atoms of carbon undergoing com-



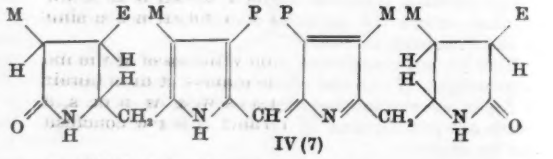
I



II (5)



III (8)



IV (7)

M = —CH₃
E = —CH₂CH₃
P = —CH₂.CH₂.COOH

plete oxidation to carbon dioxide. It is possible that there is an equilibrium between the four formally prototropic systems ('3 carbon' C=C—C—H, 'keto-enol' C=C—O—H, 'imino-enamine' C=C—N—H and 'amido-imidol' O=C—N—H) discernible in the end rings of the structures (II), (III), (IV). In this event, the structure of stercobilin might vary according to its chemical environment, and it is perhaps significant that Fischer[5] effected a higher degree of hydrogenation in acid- than in alkaline-solution. We have not, however, detected the production of any ketonic fractions such as would be expected from structures like (II) and (III) and, apart from the invariable presence of a small, non-mobile fraction, stercobilin behaves as an individual on paper chromatography and in counter-current distribution.

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C. H. Gray
D. C. Nicholson

Department of Chemical Pathology,
King's College Hospital Medical School,
Denmark Hill,
London, S.E.5.
Nov. 10.

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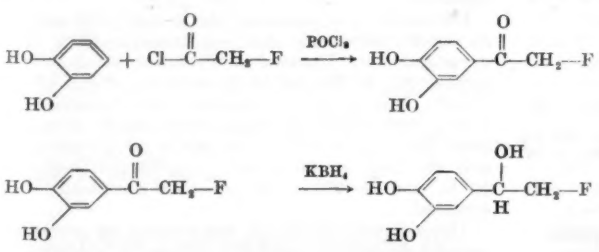
Fluoroarterenol: a Fluorine Isostere of Norepinephrine

In an investigation of the enzymatic methylation of norepinephrine, certain of the isosteres of this neurohormone, designed as antagonists of this system, have been synthesized. This communication deals with D,L-3,4-dihydroxy-(α-fluoromethyl)benzylalcohol, fluoroarterenol, its synthesis and biological properties.



3,4-Dihydroxyphenacylfluoride was prepared as follows. To 40 gm. of catechol in 150 ml. of benzene was added 25 gm. of phosphorus oxychloride and 25 gm. of fluoroacetyl chloride[1]. The reaction mixture was refluxed overnight. After the solvent was removed under reduced pressure, the residue was dissolved in boiling water, treated with charcoal and filtered; on cooling, the product crystallized out. This material was recrystallized from water. Yield, 20 gm.; melting point, 185° uncorr.; calculated for $C_8H_7O_3F$: C, 56·47; H, 4·26; F, 11·18; found: C, 56·11; H, 4·12; F, 11·90 per cent.

D,L-3,4-Dihydroxy-(α-fluoromethyl)benzylalcohol was prepared from this fluoride. 10 gm. of 3,4-dihydroxyphenacyl fluoride was suspended in 75 ml. of water, and a drop of concentrated sodium hydroxide was added. To this solution was added slowly 3·3 gm. of potassium borohydride with vigorous stirring. The temperature of the reaction mixture was maintained at 50° C. The reaction was completed in half an hour and dilute hydrochloric acid was added to *p*H 3·6. The water was stripped off under reduced pressure and the residue was treated with warm peroxide-free ethyl ether to extract the product from the potassium chloride and boric acid which resulted in the reaction. The extract was stripped free of ether under reduced pressure and the crude product was recrystallized from a mixture of ethyl acetate/chloroform. Yield, 8·7 gm.; melting point, 107°–110° C. (dec.) uncorr.; calculated for $C_8H_9O_3F$: C, 55·81; H, 5·23; F, 11·05; found: C, 55·17; H, 5·25; F, 11·73 per cent.

The mean arterial dog blood pressure was determined with a mercury manometer connected to the cannulated femoral artery of an animal anæsthetized with nembutal. While both *l*-epinephrine and *l*-norepinephrine bitartrate produced the expected pressor amine effect, fluoroarterenol in concentrations as high as 0·1 mgm./kgm. produced no change in the blood pressure of the dog. When, however, the animal was treated with the adrenolytic agent 'Dibenamine' (20 mgm./kgm.), fluoroarterenol (0·1 mgm./kgm.) produced a marked *depressor* effect similar to that produced by epinephrine (0·001 mgm./kgm.) and in contrast to norepinephrine (which produced the pressor effect in this preparation).

The effect of fluoroarterenol on the rabbit intestine was determined using the method described by Burn[2]. The isolated intestine from a freshly killed rabbit was placed in a 10-ml. chamber attached to a hooked hypodermic needle (which functioned also as an inlet for oxygen gas), and suspended from a writing lever. The preparation was permitted to relax in Ringer–Locke solution maintained at 35° C. All test material was added to the chamber at this temperature and dilutions made with Ringer–Locke solution. After each test addition to the bath, the preparation was washed three times with Ringer-Locke solution.

With 0·1 mgm./c.c. fluoroarterenol, marked relaxation of the isolated intestine, comparable to the effect produced by 0·002 mgm./c.c. of epinephrine or 0·004 mgm./c.c. of *l*-norepinephrine, was observed.

The non-pregnant rat uterus was employed to investigate the effect of fluoroarterenol on the contractions produced with acetylcholine. The uterus from a freshly killed rat was suspended in a chamber as described above. The Ringer–Locke solution used was prepared according to Burn[2]. The bath was aerated with a stream of oxygen, and its temperature was maintained at 30° C. The volume was 10 ml.

Contraction of the uterus was obtained by the addition of 0·25 γ/c.c. of acetylcholine. The test material was introduced into the bath and 30 sec. later acetylcholine was added. Both *l*-epinephrine (0·05 γ/c.c.) and *l*-norepinephrine bitartrate (5·0 γ/c.c.) showed the expected suppression of the acetylcholine-

induced contraction of the rat uterus. In contrast, fluoroarterenol in concentrations of 0·05 mgm./c.c. did not suppress the contractions in this preparation. However, at this concentration fluoroarterenol almost completely prevented the effect of norepinephrine and epinephrine on the rat uterus. Simultaneously introducing both fluoroarterenol (0·05 mgm./c.c.) and *l*-epinephrine (0·05 γ/c.c.) or *l*-norepinephrine bitartrate (5·0 γ/c.c.) into the bath permitted an almost maximal acetylcholine-induced contraction of the rat uterus.

Based mainly on the work of Gaddum[3] and Blaschko[4], the idea has been advanced that some adrenergic effects of derivatives of β-phenylethylamine are due to the inhibition of amine oxidase by these substances. Presumably, then, the inhibitors showed adrenergic effects due to their sparing action on the oxidative deamination of epinephrine. Since this may also account for the above physiological effects of fluoroarterenol, this substance was examined for its effect on liver amine oxidase.

The enzyme preparation employed was prepared as described by Blaschko, Richter and Schlossmann[4] using guinea pig liver as the source. The substrate was *l*-epinephrine. With this system, concentrations of fluoroarterenol as high as 100 μM/3 ml. ($5{\cdot}6 \times 10^{-2}$ *M*) did not inhibit the oxidation of epinephrine.

These results indicate that the fluorine isostere of norepinephrine has pharmacological activity which cannot be accounted for on the basis of its interference with amine oxidase inactivation of epinephrine. The isostere had no observable effect on the highly specific rat uterus preparation, but its competition with the epinephrine and norepinephrine activity suggests that it can associate with the specific receptors with which the pressor amines normally react. The effect of fluoroarterenol on the 'Dibenamine' dog preparation and on the rabbit intestine preparation appears to be a direct action, but evidence presented here is equivocal.

I wish to thank Dr. Harold Epley, of Winthrop Stearns, Inc., for a sample of crystalline norepinephrine bitartrate, and Miss Mary K. Devlin for her assistance with amine oxidase determinations.

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J. H. Fellman

Division of Neurology,
University of Oregon Medical School,
Portland 1, Oregon.

Nov. 6.

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X-Ray Diffraction Patterns and Alpha–Beta Transformation of a Protein extracted from the Human Epidermis

Recently, a fibrous protein has been extracted by one of us from the cellular portion of the human epidermis with 75 per cent lithium bromide[1]. The first observable microscopic change in the extracted epidermis was a disruption of tonofibrils and intercellular bridges; coincidentally, the protein appeared as an amorphous mass within the Malpighian layer and between the granular and horny layers[2]. When treated with 60 per cent acetone and 4 per cent acetic acid, the protein formed a gel. This gel could be dried as a film on silicone-coated glass. The present communication reports the results of an X-ray investigation of this substance.

X-ray diffraction diagrams of strips of the film were prepared with the beam perpendicular to the long axis of the strips and either parallel or perpendicular to the film surface, at a sample distance of 40 mm.

The two diagrams are identical, and show a strong, rather broad diffraction ring of about 5·15 A. and an extremely faint indication of a smaller ring of about 9·5 A. interplanar spacing. Intensive diffraction is present at small angle, near the primary beam (Fig. 1,*a*). The diagram shows no evidence of orientation, and from the diffuse character of the diffraction rings, it appears that the material is present in a low degree of crystallinity.

However, after immersion in cold water, the protein film became highly elastic and could be oriented by the extension method[3]. Strips of the protein 2–3 mm. wide were fixed in a clamp, immersed in cold water for 10 min. and stretched 200 per cent of their original lengths. The strips were held in the extended state for 1 hr. and allowed to contract in cold water for about 4 hr. until they reached constant length. At this time, 50 per cent contraction had occurred. The film had also become birefringent.

In parallel mount, the diagram (Fig. 1,*b*) of these strips consists of a diffuse outer scattering zone, at the inner edge of which a sharp ring of about 4·6 A. spacing can be seen with indications of higher intensities near the meridian. Close to the inside of this ring and fusing into it (forming a doublet) is a second, less distinct ring at about 4·7 A. Intense equatorial arcs of about 9·5 A. are present, extending at lower intensity through the meridian. The diagram is similar to that of 'regenerated α-keratin'[4–7] in the incompletely oriented state. With perpendicular mount, the same diffractions are principally present, but all evidence of orientation is absent. The innermost arcs are replaced by one continuous central disk. The different features of the diagrams in parallel and perpendicular mount indicate that the long axis of the molecules must have preferent orientation parallel to the surface of the film and random orientation in other planes, similar to that found with epidermal keratins[4].

For further comparison of the protein with keratin, its super-contraction and α–β transformation were investigated. Thermal contraction studies were carried out in the following manner. Strips of the protein film of known lengths were immersed for 2 min. in water at temperatures varying by 10 deg. C. from 30° C. to 100° C. The strips were then dried and the final length noted. Contraction began at 50° C. and at 90° C. 20 per cent contraction had occurred.

The α–β transformation was studied by preparing samples according to Rudall's method for 'epidermin'[4]. Protein strips were oriented by 200 per cent extension, maintained for 1 hr., followed by relaxation to constant length. The strips were then immersed in saturated ammonium sulphate at 90° C. for 2 min., removed and extended 90 per cent. They were then fixed in 10 per cent formalin for 48 hr. and finally washed.

The X-ray patterns (Fig. 1,*c*) of these samples are the same in parallel and perpendicular mount. They consist of two sharp interferences, an outer ring of spacing 4·65 A., and an inner one of 5·2 A. The

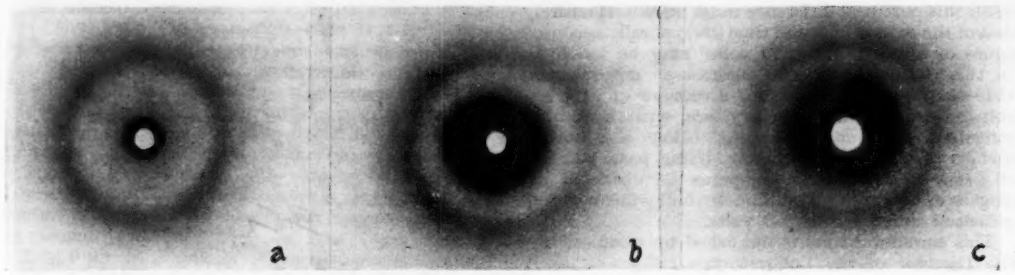

Fig. 1. X-ray diagrams of regenerated protein from human skin. (*a*) Unoriented specimen; (*b*) specimen oriented by the extension method; (*c*) specimen oriented and then extended 90 per cent after immersion in saturated ammonium sulphate at 90° C. for 2 min.

latter interference is mainly concentrated around the meridian. An innermost diffuse diffraction ring of about 9·5 A. spacing is again present and forms high-intensity arcs at the equator. These interferences are typical for α- and β-keratin. The 4·65 A. interference corresponds to the equatorial interference and 'backbone spacing' of β-keratin; the 5·2 A. interference corresponds to the meridian interference of α-keratin. The total diagram is typical for a keratin in the course of α–β transformation. (Outside these main interferences, indications of unexplained, meridian interferences of 4·15 A. were observed in some of the diagrams.)

The similarity of the X-ray diagram of the oriented sample to that of regenerated α-keratin, the α–β transformation upon stretching under suitable conditions, and the super-contraction experiments support the earlier theory that we are working with a keratinous protein. This protein is probably an unconsolidated (incompletely cross-linked) precursor of keratin, and may be related to 'epidermin'[4] and 'α-keratose'[6].

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D. Anderson Roe
Department of Dermatology,
University of Pennsylvania School of Medicine,
Philadelphia, Pennsylvania.
A. N. J. Heyn
Clemson College,
Clemson, South Carolina.

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An 8-Volt Cold-Cathode Mercury Arc emitting Microwaves

If a normal vacuum arc is struck between a liquid mercury cathode and a vertical thin tungsten wire anode a most unusual discharge may be obtained. The anode wire must be of such a diameter as to become red-hot when the arc has started and its lower (unsupported) end must then be lowered slowly toward the cathode pool. The tip of the hot wire makes a dimple in the liquid surface and the arc immediately transfers to within this dimple, the evolution of vapour from the cathode spot giving rise to sufficient hydrostatic pressure to prevent metallic contact from anode to cathode.

By careful adjustment of the depth of penetration of the anode wire below the free mercury surface, and of its temperature (altered by varying the arc current) the length of the arc may be made extremely small—probably less than 10 microns. With the 0·3 mm. diameter anode wire used in these experiments this occurs for a penetration of the same order as the wire's diameter with a mean arc current of 250–350 mA. An oscilloscope connected across the arc serves to indicate when the shortest possible discharge gap has been obtained, for then occasional shorting from anode to cathode may be observed. A one-microfarad condenser also placed across the arc greatly assists in the smooth running of the arc as well as preventing the emission of radio-frequency noise.

When the 'dimple-arc' is running under conditions of minimum length it has two notable properties. First, the arc is a copious emitter of microwave noise. A rough estimate of the power received by a crystal detector mounted in waveguide placed close to the dimple and accepting a broad band of radiation centred on 36 Gc./s. (corresponding to a wavelength of 8 mm.) indicated about 0·5 microwatt. By placing the arc in a crude form of coaxial line resonator approximately a hundred times this output was obtained in a band about 200 Mc./s. wide centred on 3 Gc./s. It appears that the origin of the microwaves is not the small plasma region between anode wire and cathode spot, for increasing the length of this materially reduces the emission. Rather, it must arise from inherent instability of the cathode electron emission process itself. The huge current density at the cathode spot[1] would (for arcs of 10μ or less) give rise to a plasma density between anode wire and cathode spot so great as to possess metallic conduction properties at any frequency below that corresponding to sub-millimetre radiation, thereby enabling the anode wire to receive microwave impulses or fluctuations arising in the cathode-fall region of the spot.

Secondly, the potential difference across the arc is remarkably low. When microwave emission is at its greatest, a d.c. meter placed from anode to cathode reads between 6·0 and 7·5 volts; but the anode potential then has the considerable high-frequency component in addition so that the true potential difference is somewhat uncertain. However, when the arc-length is increased sufficiently for the high-frequency output to be reduced to a small fraction of its maximum, but is not increased to the extreme extent that the cathode spot flies out of the dimple, then the potential difference lies between 7·8 and 8·0 volts. Since the length of the arc is still very

small this potential difference must be almost entirely that of the cathode fall and thus the generally accepted figure of approximately 10 volts[2] may be too high. In this connexion it is of interest to note that in 1929 Gaudenzi[3], searching for a rectifier of very low voltage drop, ran a mercury arc with a red-hot tungsten sheet anode dipping below the normal surface of the liquid cathode. Using peak currents of between 50 and 230 amperes he obtained arc lengths of the order of 1 millimetre and a mean overall potential difference of 9·0 volts.

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K. D. Froome

Metrology Division,
National Physical Laboratory,
Teddington, Middlesex. Nov. 14.

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Fundamental Absorption Edge of Diamond

The existence of two types of diamond was suggested in 1934 by Robertson, Fox and Martin[1]. The distinction between these types is based, among other differences, on the location of the absorption cut-off in the ultra-violet. Thus a type I diamond is transparent to radiation down to about 3000 A., whereas in a type II diamond this limit is extended to 2250 A. In diamond investigations the term 'absorption cut-off' has been used very frequently and conclusions have been drawn without taking the thickness of the specimens used for experiment into account. The seriousness of this omission is evident in this communication, where some of the results of absorption measurements on thin diamond plates are given.

Attempts to polish diamond down to a thickness of the order of 0·1 mm. met with no success, in that invariably the diamond crystal shattered when it reached a certain thickness. In cleaving a diamond (*A*), we were fortunate in obtaining a step-like thin diamond flake having steps of thicknesses 0·038 mm. and 0·127 mm. respectively and giving good transmission at 4000 A. In another attempt, plates of 0·406 mm. and 1·70 mm. were split off. Thin plates of yet another diamond (*B*), having thicknesses of 0·457 mm., 0·216 mm., and 0·058 mm., were also experimented on.

Light-absorption measurements on these plates were made at room temperature on an adapted model *DU* Beckman spectrophotometer. The transmission of the plates was measured as the ratio of the intensities with and without the specimens inserted in the beam emergent from the monochromator. The instrument has a tolerance of 1 A. at 2200 A., and 4 A. at 4200 A. Measurements were made up to 4200 A., where the transmission approaches its limit.

Transmission versus wave-length plots for the various plates of diamond are given in Fig. 1.

It is evident that it is incorrect to assign a type designation to any diamond by merely locating its absorption cut-off. Thus diamond (*B*), having a thickness of 0·457 mm., has a cut-off at about 2700 A., whereas the same diamond of thickness 0·058 mm. exhibits a cut-off only at 2220 A. In the first case, the diamond would be classified as a weak type I, whereas in the second it is definitely type II if cut-off is employed as criterion. The same observation

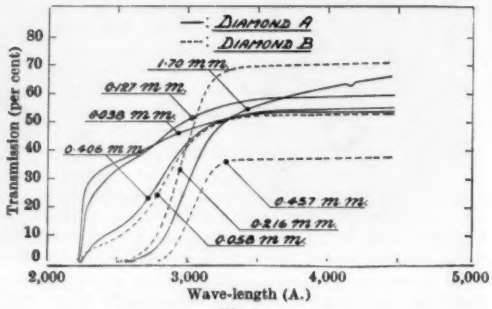

Fig. 1

applies to diamond (*A*). The thickest plate actually showed the typical type I fluorescence band[2] at 4150 A.

In Fig. 2 normalized absorption coefficients are plotted as a function of the wave-length. These were calculated by using the following relationships:

$$T = \frac{(1-r)^2 \exp(-\mu t)}{1-r^2 \exp(-2\mu t)} \quad \text{and} \quad r = \frac{(n-1)^2}{(n+1)^2}$$

where T is the observed transmission, t the thickness of the specimen, r the fraction of light reflected at diamond–air interfaces, μ the coefficient of absorption and n the refractive index of diamond, which varies with wave-length. For converting transmission into absorption coefficient values, an interpolation method as described by Clark, Ditchburn and Dyer was used[3].

From Fig. 2 it is evident that diamonds (*A*) and (*B*) exhibit a secondary absorption edge at about 3320 A., which identifies[3] them as being type I. When the specimens become sufficiently thin, the fundamental absorption edge compatible with type II diamonds makes its appearance at approximately 2220 A. The secondary absorption is superimposed on the fundamental absorption. Whether the broad secondary bands are due to minor elements or lattice defects, or both, is still undecided. An effort will be made to resolve these bands by measurements at lower temperatures.

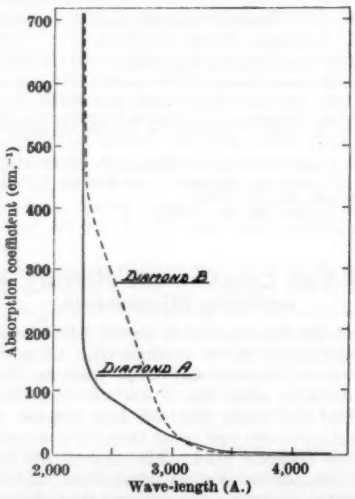

Fig. 2

The above observations seem to provide evidence that the type II absorption edge is the normal fundamental one for diamond, and suggest that type II diamonds contain fewer imperfections than type I, whatever these may be. The same conclusion was arrived at by Clark *et al.*[3], who advanced evidence that type II diamonds have fewer crystal defects than type I diamonds. They defined the fundamental absorption edge characteristic of type II diamonds as that energy E_f at which there is first observed a change of slope of the absorption spectrum due to fundamental absorption. E_f was found to be $5{\cdot}40 \pm 0{\cdot}03$ eV., which corresponds to a wavelength of 2296 ± 10 A.

In our experiments the fundamental absorption edge is taken as that energy where the absorption coefficient reaches a value of 1,000 cm.$^{-1}$. In this way a value of $5{\cdot}59 \pm 0{\cdot}3$ eV. was arrived at for both diamonds (A) and (B). This is somewhat higher than the value of Clark *et al.* but lower than the figure of 6·05 eV. quoted by Herman[4], who made a theoretical calculation of the separation between the valency band and the conduction band of diamond.

Measurements on type II (*a* and *b*) are also being carried out. The results will be published elsewhere.

We wish to thank Mr. R. Daem for his assistance in producing the diamond plates, and Mr. D. M. V. Manson for carrying out most of the absorption measurements.

Note added in proof. Somewhat similar results were obtained from wedge-shaped diamonds (thinnest portion 0·12 mm.) by K. G. Ramathan (*Proc. Ind. Acad. Sci.*, A, 24, 137; 1946).

J. F. H. Custers
F. A. Raal

Diamond Research Laboratory,
Johannesburg. Nov. 1.

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Photometry with Multiplier Photocells

Methods used for obviating the effects of variation of sensitivity over the photocathode of a multiplier photocell (of the ring-dynode type) generally involve loss of sensitivity[1]. This loss may be avoided by the use of a rotatable mirror, so as always to direct the measured light to the same cathode region[2], or of a scalloped grating which diffuses the cathode illumination[3]. From the work to be described it is concluded that the required smoothing of cathode response can also be obtained very simply by exploiting the diffraction at a sufficiently small hole placed before the photo-cathode.

It is clear from Huygens's principle that the spherical wave issuing from a sufficiently small aperture will be independent of the angle of incidence (except for cosine law variation) and of the convergence of the incident wave. Thus a photometer consisting of a multiplier cell, and a small aperture at a suitable distance before it, will always measure a fixed proportion of the issuing wave and will, therefore, give readings proportional to the intensity of the incident light, after correction, if necessary, for cosine law effects. Fig. 1 shows a photometer P of this type and the experimental arrangement for finding the required size of aperture. A compact

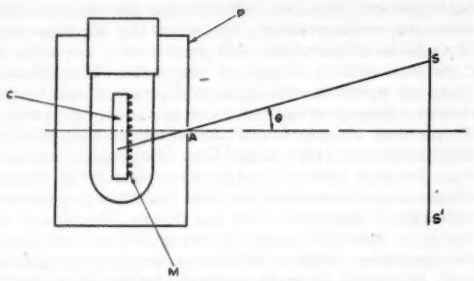

Fig. 1. Experimental arrangement for observing variation of cathode photosensitivity. S, Source; A, aperture; P, photometer; C, cathode; M, wire mesh

source at S consisting of a V-shaped filament of maximum width approximately 3 mm. was moved to S' so that the light passing through the aperture A would illuminate different parts of the length of the cathode C as long as A was sufficiently large for geometrical image formation to occur, and variations of output would take place, especially when the image on the cathode crossed one of the screening wires M. With the mean normal distance from A to C of 12·7 mm. and with AS equal to 635 mm. the cathode patch was 0·06 mm. in width (for A large), and curve A of Fig. 2 shows the variation of cell output obtained under these conditions with an aperture of diameter 5μ.

There are two distinct regions of maximum photometer sensitivity with a departure from the mean of about 30 per cent and a spacing consistent with the separation of the screening wires. There is also a gradual decrease in sensitivity of about 10 per cent per mm. towards one end (the top) of the cathode. In the experiment, the semi-field angle θ was made to correspond with the conditions used in the photometric testing of an $f/8$ lens, that is, $\tan\theta = 1/16$, and it was arranged that all the geometrical image should always fall on the cathode. The aperture was mounted on a backing plate in a solid brass support, internally blackened, to prevent extraneous illumination of the cathode. The results were obtained with 111 volts between each dynode stage and a signal-to-noise ratio of approximately 20 to 1. They agree in general form with the findings of previous work[4].

Curve C of Fig. 2 shows the effect of extending the source without change of aperture. As would

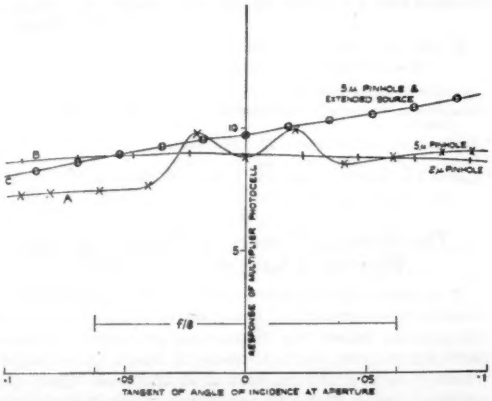

Fig. 2. Effect of scanning aperture size on variation of photosensitivity across cathode

be expected, the local effects due to the screening wires have disappeared; but since the discrete patch of cathode illumination still moves over the cathode, there is a steady change of response. The effect of using an aperture which is sufficiently small to give rise to a nearly spherical wave is shown by curve *B*, which was obtained with an aperture (supplied by the Smethurst High Light Co.) of apparent diameter 2μ. In this case not only have the local shading effects been eliminated, but also the overall systematic variation of response does not occur. To obtain this result it was necessary to bring the source nearer the aperture, greater brilliance being impracticable and increased dynode voltage being undesirable; but the relationship between the significant dimensions was not altered greatly (the cathode patch would have been 0·35 mm. × 0·09 mm. by geometrical theory, which would be quite small enough to lead to detectable effects). It is therefore clear that the use of a sufficiently small aperture can provide a suitable basis for accurate photometry. In curve *B* some variation of response remains, but after correcting for inverse square law variation (0·4 per cent) and cosine law variation (0·2 per cent) the response of the photometer is constant to within ± 1 per cent. On repetition of the experiment, but with the source displaced so as to tend to move the image across the cathode, the same result was obtained.

The results are of importance in deriving spatial frequency responses from direct measurements of the intensity distributions in 'point' images formed by lenses under test. If the photometer aperture is large, a real image of the last surface of the lens under test will be formed by pin-hole camera action on the cathode and, on scanning the point image, the cathode patch will move (and otherwise change in the presence of zonal aberrations), as P. D. Carman has pointed out to me. Taking the inclusion of the first Fresnel zone as the criterion for the pin-hole camera effect, the aperture should then have a diameter of approximately 160μ, for $\lambda = 0{\cdot}5\mu$ and $AC = 12{\cdot}7$ mm. This is much larger than the value of 5μ at which some vestige of geometrical image formation has been found to remain; though clearly the image on the cathode must then have been quite diffuse. When the aperture is reduced to a size which includes only $(1/80)^2$ of the first Fresnel zone, or the diameter is 4 wave-lengths in the photometer described here, no noticeable pin-hole camera effect remains and a reliable, simple photometer is obtained.

J. M. Naish

Royal Aircraft Establishment,
Farnborough, Hants.
Nov. 9.

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The General Theory of Relativity and Newton's Law of Gravitation

It is generally believed that the general theory of relativity is a theory of gravitation which treats only the case for which the Newtonian attraction between particles m_1, m_2 at a distance d apart is $\gamma m_1 m_2/d^2$, where γ is a constant, and that the case when γ is replaced by a variable quantity γ' is beyond the scope of the theory. I do not believe that this is the case, and in the following argument I endeavour to show that the general theory of relativity can, in fact, treat the case when γ' is a slowly varying function of the time, of the type found in Dirac's cosmology[1].

Newton's law of gravitation can be derived in two cases from the theory of relativity: (1) for weak static fields of matter at rest; (2) for the field of a homogeneous pressure-free distribution of expanding matter. These cases are usually treated rather differently: in (1) a system of 'local' co-ordinates is chosen so as to make space-time quasi-Minkowskian, and the analogue of Poisson's equation is found from the relativistic equations; and in (2) the equations of motion of matter are derived for a system of 'cosmic' co-ordinates which are then found to have their exact analogue in Newtonian theory[2]. Either case can be used to determine the value of the Einstein constant $\varkappa = 8\pi\gamma/c^2$. Usually (1) is used for this purpose, but it would seem to be preferable to define $\varkappa$ by (2) and to derive the local field by joining a centrally symmetric field on to the field of the expanding universe. I have found that when this is done, the 'local' distance is the same as 'cosmic' distance, and 'local' time is approximately the same as 'cosmic' time. One can therefore say that the general theory of relativity exhibits Newton's law of gravitation with constant γ in 'cosmic' co-ordinates.

If one now replaces 'cosmic' distance ρ by a new distance $r = \lambda\rho$ ('atomic' distance), where λ is a slowly varying function of the time, one finds that the relativistic equations have the Newtonian form for the previous cases (1) and (2), when γ is replaced by γ', a slowly varying function of the time. If one then introduces the condition that γ' shall have the same value for (1) and (2), in order to ensure that the law of gravitation is universal, it is found that γ' varies inversely as the epoch, in agreement with the result found in Dirac's cosmology.

Thus the general theory of relativity may be said to exhibit Newton's law of gravitation in two different forms. In one form 'cosmic' distance corresponds to Newtonian distance and γ is a universal constant; in the other form, 'atomic' distance corresponds to Newtonian distance and γ is replaced by γ', which varies inversely as the epoch.

C. Gilbert

Department of Mathematics,
King's College,
Newcastle upon Tyne.
Oct. 19.

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Carbonatites in Kivu

In 1952 [1] one of us described specimens of syenitic and carbonate rocks collected in northern Kivu, near the south-western termination of the Lake Edward Rift, by Borgniez, in 1938 [2]. The junior author has recently had the opportunity of revisiting the locality and has established the carbonatitic nature of the carbonate rocks.

This carbonatite plug extends a little more than a mile in the Lueshe Valley and is intrusive in pelitic schists of the Urundi–Ruzizi series, striking regionally N. 50° W. (magnetic). These schists of garnet or cyanite grade show a rather mild type of metamorphism[1,3] which has scarcely destroyed their sedimentary characteristics. They include, immediately west of the carbonatite, a metamorphosed

limestone lens (quite distinct from the carbonatite) and sheridanite schists.

The carbonatite is surrounded by a ring of a nepheline-free cancrinite–calcite–syenite which we propose to designate by the name of 'busorite'.

The carbonatite itself is either an aegyrine-carbonatite (ringite) or a biotite carbonatite (sövite). These rocks form a plug one mile wide and occur also as dikes in the surrounding busorite or in the metasomatized Urundi schists. The strike of the surrounding schists suggests a diapiric pressure effect of the carbonatite plug.

The extent to which the busorite is eruptive or fenitic is not yet clear, but other metasomatic effects are noteworthy, especially in the Urundi schists which are locally transformed in what one of us[1] termed sodic-amphibolites, that is, fine-grained granoblastic rocks composed of alkali-feldspars, aegyrine and an alkalic-amphibole.

The peculiar character of this metasomatic aureole seems to be due to the fact that the carbonatite is not intrusive into a granitic basement as is the case at Fen, Alnö and the many Central and South African examples, but in meta-sediments.

Genetically, the carbonatite is related either to the limestone lens, or to the potassic province of the Virunga volcanoes (Northern Kivu Province). The first hypothesis being quantitatively somewhat inadequate, the second seems to be more probable.

P. de Béthune

Institut Géologique,
Université de Louvain.

A. Meyer

Service Géologique du Congo Belge
et du Ruanda Urundi,
Goma.

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Size and Abundance of Phenocrysts in Lavas of Terrestrial and Geosynclinal Environments

A striking difference is noticeable in New Zealand in the number and abundance of phenocrysts in basaltic and andesitic lavas erupted in different environments.

Most flows erupted on land or in shallow seas and on geosynclinal shelves contain numerous and abundant phenocrysts of either feldspar or ferromagnesian silicates or both. Except perhaps for the colour of a rock, they are usually the most noticeable feature in a hand specimen. In the deeper waters of geosynclines lavas with noticeable phenocrysts are rare or absent.

There are several examples in New Zealand of thick assemblages of flows erupted on land and in adjacent shallow seas since the Miocene, and they are all characterized by many large phenocrysts.

Flows at several horizons among Cretaceous sediments deposited in deep marine basins (small geosynclines) are dominantly even-grained, and aphyric or microphenocrystic.

The degree of development of phenocrysts in flows in the major upper Paleozoic and lower Mesozoic geosyncline[1] of New Zealand is closely related to whether the flows occur at the margin, or at the knee-bend, or near the axis of the geosyncline. On the shelf, west of the knee-bend, several thousands of feet of lavas, pillow lavas and tuffs in Brook Street Formation were erupted mainly in a shallow-water marine environment. Nearly all the flows contain idiomorphic phenocrysts of basaltic augite (oxidized diopsidic augite) frequently more than a quarter of an inch in length and making up 20 per cent of the rock by volume. Consequently, Brook Street lavas have such a striking and characteristic appearance that samples of them can be recognized readily in river gravels and rock collections. Farther east, in the deeper waters near the knee-bend of the geosyncline, thick assemblages of lavas were erupted on both limbs of the Marginal Syncline[1] as part of the Upper Te Anau Group of Carboniferous or Lower Permian age. The west limb of this syncline is generally hidden beneath younger beds; but it is exposed intermittently for several tens of miles along the strike at the south end of the South Island, where the lavas contain fewer and smaller phenocrysts than the Brook Street lavas. In the east limb of the Marginal Syncline, which is exposed at both ends of the South Island, augite phenocrysts, in the occasional flows that contain them, are even fewer and smaller, being often scarcely larger than the crystals of augite in the ground-mass. Beyond the Marginal Syncline, in the axial ranges of both North and South Islands, among the extremely thick graded sediments east of the knee-bend in the geosyncline, there are lavas at several horizons. They are aphyric and so even-grained that they can be mistaken in the field for fine-grained greywacke if they do not show pillow-structure or if they are not associated with red and green coloured siliceous and calcareous sediments.

Large phenocrysts will form in a magma as it moves towards the surface if the temperature falls and if there is sufficient time for growth. These conditions must occur to the greatest extent where the movement of magma is towards a terrestrial surface, to a lesser extent where it is towards a geosynclinal shelf surface, and to a negligible extent where it is towards a surface in the deeper parts of a geosynclinal trough. Presumably, the distance travelled by magmas moving to the floors of a geosynclinal trough near its axis is insufficient to allow time for the growth of large phenocrysts.

H. J. Harrington

Geological Survey,
P.O. Box 8002,
Wellington, C.1,
New Zealand.
Nov. 9.

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Erpocotyle abbreviata (Olsson, 1876) Price, 1942, a Monogenetic Trematode New to British Waters

Erpocotyle abbreviata (Olsson, 1876) Price, 1942 (=*Squalonchocotyle abbreviata*, Cerfontaine, 1899), is a parasite found on the gills of *Squalus acanthias* L. (the spur dog). Full details of the taxonomy of the species and genus are given in Dawes[1,2] and Sproston[3]. The trematode was first recorded by Olsson from the Skagerrak. Cerfontaine recorded it from Roscoff, and Sproston found one specimen on each of two male spur dogs from the same locality. The latter author

refers to Layman, who obtained specimens from the Pacific Coast of the U.S.S.R. Brinkmann[4] recorded the species from Byfjord (Bergen) in Norway, where he found two infected fish out of six examined. Until recently, it has not been found in British waters, although its occurrence at Roscoff and in Norwegian waters suggests that it may not be uncommon around our shores.

In June 1953, three specimens of *E. abbreviata* were obtained from the gills of a male spur dog which was trawled from the Irish Sea in a depth of 30–35 fathoms on muddy sand about five miles north-west of Bradda Head, Isle of Man. More recently, in September 1956, ten large (77–98 cm.) female spur dogs caught by herring ring-net boats off the Isle of Man (precise locality unknown) were examined, and four of them found to harbour *E. abbreviata*.

Some of the trematodes were attached to the gill filaments, and others to the wall of the gill chamber; but as the fish were not examined for some time (24–36 hr.) after they were caught, it is possible that the parasites may have moved from their original positions.

The lengths of six of the specimens obtained in September 1956 varied between 4·5 and 6 mm., measured when they were fully relaxed in chloretone. This is rather smaller than Cerfontaine's specimens (7–8 mm.), but about the same size as those described by Olsson (4–6 mm.) and Brinkmann (3·9–6·7 mm.).

A full description will be published later.

I wish to thank Dr. B. Dawes, of King's College, London, who examined two of the specimens found in 1953 and agreed with my identification.

D. J. Slinn

Marine Biological Station,
Port Erin.
Nov. 14.

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Tricotyly in the Tomato

Haskell[1] found that the proportion of tomato seedlings with divided or extra cotyledons varied from truss to truss on the variety Clucas-99. Seeds from the first and fourth trusses included a higher proportion than the second and third.

This variation between trusses could have been caused by the position of the truss on the plant, as Haskell suggested, or by temporal variations in the causal factor which might be associated with the stage of growth of the plant, or with variations in the environment. Successive trusses on tomatoes normally have a few fruits developing together. By sowing seeds from individual fruits, it should be possible to distinguish true truss- or position-effects from time-effects with which they may be confounded.

Some plants of the variety Harbinger were grown for this purpose. All were from one selfed fruit, and of the 175 seedlings grown, five had divided cotyledons. In 1955 fruits were harvested from four plants, of which two were dicotyledons, whereas two had divided cotyledons. From the fruits of the first five trusses on the main stem of these plants 4,223 seedlings were grown, of which 4,204 were dicotyledons. There were no significant differences in the frequency of tricotyledons from different plants, trusses or fruits.

Table 1. Distribution of Tricotyledons between Plants

Plant No.	Origin	Description	Treatment	No. of fruits	Dicotyledons	Tricotyledons
*H*9/1	Cutting from *H*9	Dicot.	Pruned	55	3,469	17
*H*9/2	Cutting from *H*9	Dicot.	Not pruned	34	2,555	6
*H*11	Seedling	Tricot.	Not pruned	55	3,937	30
*H*12	Seedling	Dicot.	Pruned	92	6,783	53
*H*13	Seedling	Dicot.	Pruned	72	4,511	2
*H*14	Seedling	Dicot.	Not pruned	62	3,067	7

Table 2. Fruits with a High Proportion of Tricotyledons

Plant	Dicotyledons	Tricotyledons	p^*	Plant	Dicotyledons	Tricotyledons	p^*
*H*11	56	3	0·0094	*H*12	81	5	0·0005
	129	3	0·0774		39	5	<0·0001
	102	3	0·0443		29	3	0·0019
	38	6	<0·0001		54	4	0·0011
					63	3	0·0148
					103	3	0·0499

*p was calculated from the totals for each plant separately.

In 1956 six plants were grown. Two were grown from cuttings of one of the plants used in 1955, and the others were from the original batch of seed. From three of these plants laterals were removed as they appeared; the others were not pruned. A much higher yield of viable seed was obtained this year, and of the 24,437 seeds germinated, 115 were tricotyledons. Their distribution is given in Table 1.

As can be seen, different plants had different frequencies of tricotyledons. This difference remains unexplained. Pruning apparently had no effect on their frequency. Tricotyledons were rare on plants *H*9/1, *H*9/2, *H*13 and *H*14. So far as could be detected, tricotyledons occurred at random in seeds from different fruits or trusses of each of these plants.

Among fifty-five fruits of *H*11, four had more than two tricotyledons, *H*12 had 92 fruits, and six contained more than two tricotyledons. The numbers of tricotyledons and dicotyledons grown from these fruits, and the probabilities that these numbers of tricotyledons would occur in these fruits if they were distributed at random within each plant, are given in Table 2.

Some fruits contained a significantly higher proportion of tricotyledons than others. The proportion of fruits bearing tricotyledons did not vary significantly from truss to truss on these plants. Tricotyledons are apparently not always distributed on tomatoes as they were on the plants of Clucan-99 which Haskell observed.

It would seem from these results that some factor, which varied from time to time and from plant to plant, caused the production of the tricotyledons.

T. P. Palmer

Crop Research Division,
Department of Scientific and Industrial Research,
Christchurch, New Zealand.

[1] Haskell, G., *Nature*, **173**, 311 (1954).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 4

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. B. W. Sparks, Col. C. A. Biddle and Mr. R. A. Hamilton: "Surveying Aneroids: Uses and Limitations".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO AND TELECOMMUNICATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Informal evening on "The Importance of Research in Hearing and Seeing to the Future of Telecommunication Engineering". Talk by Dr. E. C. Cherry.

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. E. C. Le Jeune: Presidential Address.

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. S. J. Davies: "The Undergraduate and Postgraduate Education of Engineers in European Countries".*

UNIVERSITY OF LONDON (at the Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Major-General Cyril Lloyd: "The Impact of Technical Studies".*

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the LONDON SECTION and the PLASTICS AND POLYMER GROUP, at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Prof. G. N. Natta (Milan): "Isotactic Polymers".

Tuesday, February 5

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. A. J. Arkell: "The Oldest Stone Building in the World".*

CEMENT AND CONCRETE ASSOCIATION (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. Y. Guyon: "Large-span Prestressed Concrete Bridges Constructed by the Freyssinet System".

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. R. C. Pratt and others: "Liquid-Liquid Extraction".

Wednesday, February 6

INSTITUTION OF NAVAL ARCHITECTS (joint meeting with the INSTITUTE OF MARINE ENGINEERS, in the Weir Hall, Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1), at 10 a.m.—Symposium on "The Education and Training of Naval Architects and Marine Engineers".

ROYAL SOCIETY OF ARTS (at John Adam Street, London, W.C.2), at 2.30 p.m.—Prof. I. C. F. Statham: "Mining Education and Training" (Cadman Memorial Lecture).

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. T. N. George and Dr. D. H. Oswald: "The Carboniferous Rocks of the Donegal Syncline"; Dr. M. R. W. Johnson: "The Tectonic Phenomena Associated with the Post-Cambrian Thrust Movements at Coulin, Wester Ross".

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. J. T. Tyson: "Patents in the Petroleum Industry".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "The Place of Liberal Studies in Sandwich and other Technological Courses".

UNIVERSITY OF LONDON (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 6.30 p.m.—Dr. H. J. Plenderleith: "Preservation of Metals".* (First of six lectures on "The Scientific Laboratory in the Service of Art and Archæology". Further lectures on February 13, 20, 27, March 6 and 13.)

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (at Birkbeck College, Malet Street, London, W.C.1), at 8 p.m.—Annual Meeting. Dr. C. N. Coffey (University of California): "The Group as a Focus of Psychological Study".

Thursday, February 7

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. Victor B. Scheffer: "The Fur-seal Islands of Alaska"; Prof. R. Vaz Ferreira: "The Seal Islands of Uruguay".

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Prof. F. Bergel: "Chemical Aspects of Psychopharmacology".*

INSTITUT OF REFRIGERATION (at the Junior Institution of Engineers, Pepys House, 14 Rochester Row, Westminster, London, S.W.1), at 5.30 p.m.—Dr. Ella M. Barnes: "Antibiotics for the Preservation of Perishable Foods"; Dr. R. S. Hannan: "A Discussion of the Possibilities of Using Ionizing Radiations for Preserving Foods".

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting with the INSTITUTIONS OF CIVIL AND MECHANICAL ENGINEERS, at Savoy Place, London, W.C.2), at 5.30 p.m.—Sir Ifor Evans: "The Place of Engineering in University Education" (Third Graham Clark Lecture).

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. H. M. Sinclair: "Vitamins in Nutrition".* (Ninth of fifteen lectures of "The Scientific Basis of Medicine", organized by the British Postgraduate Medical Federation.)

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 17 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. Bengt Kjellgren: "Beryllium".

Friday, February 8

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Anniversary Meeting—"Probability Theory in Astronomy" (Presidential Address); followed by the Annual General Meeting.

UNIVERSITY OF LONDON (in the Beveridge Hall, Senate House, London, W.C.1), at 6 p.m.—Sir Mortimer Wheeler: "The Virtue of Intolerance" (Birkbeck College Foundation Oration).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Claude Gibb, F.R.S.: "The Story of the Turbine, Steam and Gas".

Saturday, February 9

BRITISH PSYCHOLOGICAL SOCIETY (in the Gustave Tuck Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Prof. D. Bindra (McGill University): "Current Psychological Research at McGill University".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. Gwynne Vevers: "Animal Life in the Arctic".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

FOOD CHEMIST (with a first- or second-class honours degree or equivalent in biochemistry or chemistry, and experience in food research) at the Wantage Radiation Laboratory, to study the chemical changes brought about in foodstuffs by irradiation—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting Ref. 690/2 (February 7).

GRADUATE TO ASSIST IN THE ELECTRON MICROSCOPY SECTION of the Cavendish Laboratory on work in X-ray microscopy and related aspects of electron physics—The Secretary to the Department of Physics, Cavendish Laboratory, Free School Lane, Cambridge (February 9).

LECTURER (medical or non-medical graduate) IN MEDICAL STATISTICS—The Registrar, The University, Manchester 13 (February 9).

RESEARCH ASSISTANT to the Head of the Department of Botany—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (February 13).

TUTORIAL STUDENT (graduate) IN MECHANICAL ENGINEERING—The Registrar, King's College, Strand, London, W.C.2 (February 14).

LECTURER IN ZOOLOGY—The Secretary, The Queen's University, Belfast (February 15).

UNIVERSITY DEMONSTRATOR OR UNIVERSITY ASSISTANT LECTURER IN THE DEPARTMENT OF GEOGRAPHY—The Secretary of the Appointments Committee, Department of Geography, The University, Downing Place, Cambridge (February 16).

LECTURER IN APPLIED MATHEMATICS; and an ASSISTANT LECTURER IN PURE MATHEMATICS—The Registrar, University College of North Staffordshire, Keele, Staffs (February 20).

CHEMIST (METALLURGIST) (with an honours degree in metallurgy or Associateship of the Institution of Metallurgists, or equivalent qualifications) with the Ministry of Supply, at Test House, Harefield, Middlesex, to be in charge of a metallographic laboratory covering all metallic materials used in the construction of aircraft, in particular, alloy steels and wrought light alloys—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.857/6A (February 21).

LECTURER IN GEOLOGY at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (February 22).

HEAD (with high qualifications in chemistry and experience in both teaching and research) OF THE DEPARTMENT OF CHEMISTRY—The Principal, Chelsea Polytechnic, London, S.W.3 (February 23).

LECTURER IN THE INSTITUTE OF EDUCATION—The Registrar, University College, Leicester (February 27).

LECTURER IN THE DEPARTMENT OF APPLIED MATHEMATICS—The Registrar, The University, Liverpool (February 28).

READER OR SENIOR FELLOW; and a SENIOR RESEARCH FELLOW OR RESEARCH FELLOW, IN THE DEPARTMENT OF THEORETICAL PHYSICS, Research School of Physical Sciences, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 28).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWS IN PHYSICS, CHEMISTRY, ENGINEERING, METALLURGY AND PHARMACOLOGY OR any related subject—The Registrar, The University, Liverpool (March 1).

LECTURER IN ZOOLOGY; and a LECTURER OR SENIOR LECTURER IN BOTANY at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, March 1).

LECTURER (with a good honours degree in physics or chemistry and experience of teaching both subjects in a school) IN EDUCATION—The Registrar, The University, Liverpool (March 1).

TUTORIAL FELLOW or STUDENT IN GEOGRAPHY—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (March 1).

LECTURER IN ORGANIC CHEMISTRY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, March 2).

IMPERIAL CHEMICAL INDUSTRIES FELLOWS (2) at Durham or Newcastle, for research in Chemistry, Physics and allied subjects, including the biological application of chemistry—The Registrar, University Office, 46 North Bailey, Durham (March 4).

SENIOR LECTURER OR LECTURER IN HÆMATOLOGY; and a LECTURER IN MORBID ANATOMY, at University College, Ibadan, Nigeria—The Secretary, Senate Committee on Colleges Overseas in Special Relation, Senate House, London, W.C.1 (March 4).

READER IN MECHANICAL ENGINEERING at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 7).

LECTURER IN MORAL AND POLITICAL PHILOSOPHY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, March 8).

HEAD OF THE DEPARTMENT OF SOIL MICROBIOLOGY—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (March 14).

LECTURER IN EDUCATION at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (March 15).

AGRONOMIST, and a SOILS CHEMIST or PHYSICIST, at the Rubber Research Institute of Malaya, Kuala Lumpur, Federation of Malaya, to work on soil problems—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (March 30).

LECTURER IN THE DEPARTMENT OF PSYCHOLOGY, Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, March 31).

ASSISTANT EXPERIMENTAL OFFICER (CHEMIST or PHYSICAL CHEMIST) AT THE FOOD INVESTIGATION LOW TEMPERATURE RESEARCH STATION (D.S.I.R.), Cambridge, to assist in studying the chemistry and biochemistry of spoilage in eggs—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.14/7A.

ASSISTANT (Grade B) TO TEACH PHYSICS—The Principal, Technical College, Queen Street South, Huddersfield.

ASSISTANT PHYSICIST attached to the RADIOTHERAPY DEPARTMENT, for duties which include routine radiotherapy physics and clinical uses of radioactive isotopes—The House Governor, Charing Cross Hospital, London, W.C.2.

CHAIR OF ENGINEERING MATHEMATICS in the Department of Mathematics—Prof. R. L. Jeffrey, Queen's University, Kingston, Ontario.

HEAD (with a good honours degree and experience) OF THE GEOGRAPHY DEPARTMENT—The Head Mistress, Roedean School, Brighton.

MASTER TO TEACH ZOOLOGY AND BOTANY to scholarship level, and GENERAL SCIENCE to ordinary level; and a MASTER TO TEACH MATHEMATICS to scholarship level—The Headmaster, Bridlington School, Bridlington.

PHYSICIST (with a first- or second-class honours degree in physics) IN THE MINES AND GEOLOGICAL DEPARTMENT, Government of Kenya, for geological survey work with special reference to spectrographical and X-ray determination of minerals—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.99/7/02.

PLANT SUPERVISOR (with experience of biochemical processes) IN THE DEPARTMENT OF CHEMICAL ENGINEERING, for plant already established under the auspices of the Medical Research Council, for the preparation of Coenzyme A and other biochemical reaction promoters—The Secretary, University College, Gower Street, London, W.C.1, quoting Chem.Eng./5.

PLANT PATHOLOGISTS (under 40, with a first- or second-class honours degree in agriculture or botany, and at least two years experience of seed testing and/or seed-borne diseases of crops) IN THE DEPARTMENT OF AGRICULTURE, Tanganyika, to initiate a seed testing service, carry out research into seed-borne diseases, and prepare legislation relating to seed production and export—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/8/08.

TECHNICIAN IN THE DEPARTMENT OF ANATOMY—The Bursar, The University, Sheffield 10.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Nickel Plating for Engineers. Pp. 72. (London: The Mond Nickel Company, Ltd., 1956.) [312

The Hungry Thief: the Problem of the Desert Locust. Pp. 36. (London: The Shell Petroleum Co., Ltd., 1956.) [312

Institution of British Agricultural Engineers. Year Book, 1956–57. Pp. 116. (Brighton: Fraser Pearce, Ltd., 1956.) [312

Planning. Vol. 22, No. 404 (3 December 1956): Solving Traffic Problems—2: Plans for Britain. Pp. 205–220. (London: Political and Economic Planning, 1956.) 2*s.* 6*d.* [312

Ministry of Agriculture, Fisheries and Food. Fishery Investigations. Series 2, Vol. 20, No. 6: The Biology and Distribution of the Slipper Limpet *Crepidula fornicata* in Essex Rivers, with Notes on the Distribution of the Larger Epibenthic Invertebrates. By P. R. Waine. Pp. ii+50. 10*s.* net. Series 2, Vol. 20, No. 9: Experimental Rearing of the Larvæ of *Ostrea edulis* L. in the Laboratory. By P. R. Waine. Pp. ii+23+2 plates. 6*s.* net. (London: H.M. Stationery Office, 1956.) (712

Regional Organisation of Further Education in England and Wales. Constitution and Functions of Regional Advisory Councils and Local Authority Areas included in each Region. Pp. 12. (London: Regional Advisory Council for Higher Technological Education, 1956.) 2*s.* [712

Coal Tar Research Association. Review of Coal Tar Technology, January–June 1956. (Vol. 8, Part 1.) Pp. ii+94. (Gomersal: Coal Tar Research Association, 1956.) 7*s.* 6*d.*; 1.50 dollars. [712

Transactions of the Royal Society of Edinburgh. Vol. 63, Part 1—(No. 8): Studies of Floral Morphogenesis. 1: Median Bisections of Flower Primordia in *Primula bulleyana* Forrest. By Frank Cusick. Pp. 153–166+2 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 6*s.* [712

London County Council: Public Health Department—Scientific Branch. Annual Report of the Scientific Adviser for the year 1955. Pp. 28. (London: London County Council, 1956.) 1*s.* [1412

Annual Report of the Chief Inspector of Factories for the year 1955. Pp. 275. (Cmnd. 8.) (London: H.M. Stationery Office, 1956.) 9*s.* net. [1412

Discovery Reports, Vol. 28. Pp. 237–298+plates 1 and 2 (December 1956): Sperm Whales of the Azores. By Robert Clarke. (Cambridge: At the University Press, 1956.) 27*s.* 6*d* net. [1412

Bulletin of the British Museum (Natural History). Zoology. Vol. 4, No. 8: *Sagitta Planctonis* and Related Forms. By P. M. David. Pp. 435–451+plate 11. (London: British Museum (Natural History), 1956.) 6*s.* [1412

Laboratory Animals Bureau. Collected Papers, Vol. 4, 1956: Report of a Symposium on Infections in Laboratory Animals, held at the Royal Veterinary College, London, on 13th April, 1956. Pp. 68. (London: Laboratory Animals Bureau, M.R.C. Laboratories, 1956.) 7*s.* 6*d.* [1412

Other Countries

Proceedings of the United States National Museum. Vol. 106, No. 3365: A New Pinecone Fish, *Monocentris reedi*, from Chile, a New Family Record for the Eastern Pacific. By Leonard P. Schultz. Pp. 237–240+1 plate. Vol. 106, No. 3370: A New Species of Candacia (Copepoda: Calanoida) from the Western North Atlantic Ocean. By Abraham Fleminger and Thomas E. Bowman. Pp. 331–338. Vol. 106, No. 3371: Emended Description and Assignment to the New Genus *Ronalea* of the Idotheid Isopod *Erichsonella Pseudoculata* Boone. By Robert J. Menzies and Thomas E. Bowman. Pp. 339–344. Vol. 106, No. 3372: Observations on the Amphipod Genus *Parhyale*. By Clarence R. Shoemaker. Pp. 345–358. Vol. 106, No. 3374. Further Data on African Parasitic Cuckoos. By Herbert Friedman. Pp. 377–408. Vol. 106, No. 3376: A New Genus and Species of Marine Aselote Isopod, *Caecianiropsis psammophila*, from California. By Robert J. Menzies and Jean Pettit. Pp. 441–446. (Washington, D.C.: Smithsonian Institution, U.S. National Museum, 1956.) [312

Bulletin of the Astronomical Institutes of the Netherlands. Vol. 13, No. 469 (1956 October 20): A Model of the Upper Photosphere from Eclipse Photometry of the Solar Limb. By H. Hubenet and C. de Jager. Pp. 43–50. Vol. 13, No. 470 (1956 November 9): Radial Velocities of σ Persei and ξ Persei. By A. B. Muller, Th. Walraven and L. Woltjer. Pp. 51–76. Vol. 13, No. 471 (1956 November 15): A Study of Bright Rims in Diffuse Nebulæ. By S. Pottasch. Pp. 77–88. (Leiden, Utrecht, Groningen and Amsterdam: Astronomical Institutes of the Netherlands, 1956.) [312

Göteborgs Kungl. Vetenskaps- och Vitterhets-Samhälle. Reports of the Swedish Deep Sea Expedition, 1947–1948. Vol. 3, Fasc. 3: Physics and Chemistry. The Equatorial Currents in the Pacific Ocean. By N. G. Jerlov. Pp. 127–154. 10 Sw. kr. Vol. 4, Fasc. 2: Bottom Investigations. Echo Soundings. By F. F. Koczy. Pp. 99–158+profiles 1–23. 40 Sw. kr. Vol. 5, Fasc. 2: Sediment Cores from the East Pacific. Proportion of Sedimentary Components in the Calcareous Eupelagic Area of the East Pacific. By G. Arrhenius and N. Blomqvist. On the Variation of the General Circulation of the Atmosphere During Past Ages. By A. Nyberg. Pp. 231–244. 4 Sw. kr. Vol. 6, Fasc. 2: Sediment Cores from the West Pacific. Chemical Analyses of Cores from the Central and West Equatorial Pacific. By G. R. Berrit and H. Rotschi. P. 53–58+22 graphs. 15 Sw. kr. (Göteborg: Elanders Boktryckeri Aktiebolag, 1956.) [312

Rijkslandbouwhogeschool. Achtste Jaarlijks Symposium over Phytopharmacie, 8 Mei 1956. (Overgedrukt uit "Mededelingen van de Landbouwhogeschool en de Opzoekingsstations van de Staat te Gent" 1956. Band 21, Nr. 3.) Pp. ii+293–642. (Gent: Rijkslandbouwhogeschool, 1956.) [312

United States Naval Observatory. Circular No. 70: Positions, Areas, and Counts of Sunspots, May, 1956. By Winifred Sawtell Cameron. Pp. 8. (Washington, D.C.: U.S. Naval Observatory, 1956.) [712

World Food Problems—No. 1: Nutrition and Society. Pp. 54. (Rome: Food and Agriculture Organization of the United Nations; London: H.M. Stationery Office, 1956.) 1*s.* 3*d.*; 0·25 dollars. [712

Exhibition of Works of Primitive Art of the National Museum of Victoria, the National Gallery of Victoria, the Ethnographical Collection of the University of Melbourne, and private collections. Pp. 19+1 plate. (Melbourne: National Gallery of Victoria, 1956.) 1*s.* [712

National Museum of Victoria, Melbourne. Memoirs. No. 22, Part 1 (23 July, 1956): Australian Fish Hooks and Their Distribution. By Aldo Massola. Pp. 16. No. 22, Part 2 (25 July, 1956): A Check List of Australian Elateridæ (Coleoptera). By A. Neboiss. Pp. 75. No. 22, Part 3 (23 July, 1956): Victorian Aboriginal Strangling Cords. By Aldo Massola. No. 22, Part 4 (25 July, 1956): Mollusca from South East of King Island, Bass Strait. By Charles J. Gabriel. Pp. 16. (Melbourne: National Museum of Victoria, 1956.) [712

Selected Problems of Production and Trade in the Near East. Pp. vi+168. (Rome: Food and Agriculture Organization of the United Nations; London: H.M. Stationery Office, 1956.) 8*s.* 9*d.*; 1.75 dollars. [712

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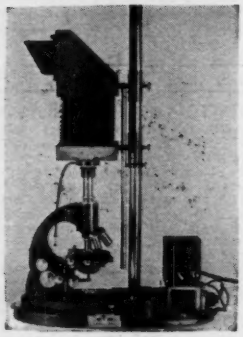

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